# NAVAL POSTGRADUATE SCHOOL
# MONTEREY, CALIFORNIA


# THESIS

**META ANALYSIS
ON HIGH QUALITY RECRUITING
ENLISTMENTS**

by


YEON CHANG CHUNG


September, 1995

Thesis Advisor: So Young Sohn

**Approved for public release; distribution is unlimited.**

# REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188



| | | |
|---|---|---|
| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE September, 1995 | 3. REPORT TYPE AND DATES COVERED Master's Thesis |

4. TITLE AND SUBTITLE
META ANALYSIS ON HIGH QUALITY RECRUITING ENLISTMENTS

5. FUNDING NUMBERS

6. AUTHOR YEON CHANG CHUNG

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(maximum 200 words)*

The success of the U. S. military recruiting depends not only on recruiting efforts but also on the labor market conditions. In this thesis, the econometric literature of military recruiting analysis based on historical data from FY81 to FY89 is reviewed. The random effects meta analysis models are used to examine the systematic variation in high quality enlistment elasticities obtained over different studies with respect to advertising, recruiter forces, and unemployment rate, respectively.

The results of the meta analysis show that (1) the Army advertising turns out to be more effective than that of the other military services; (2) the models with the recruiting goal factor tend to have significantly smaller recruiting elasticities with respect to advertising and recruiter forces than their counterpart; (3) the unemployment rate elasticities do not vary significantly over different studies; (4) the Army advertising elasticity on the high quality contract is relatively low compared to the unemployment rate and the recruiter elasticities; (5) in terms of cost, the military expenditure for the recruiters appears to be more cost-effective in producing quality recruits than advertising expenditure, when the cumulative long-run effects for advertising were ignored. These findings are expected to give some insights into future military recruiting.

| | |
|---|---|
| 14. SUBJECT TERMS High Quality Enlistments, Labor Market conditions, Recruiting Efforts, Elasticity, Meta Analysis. | 15. NUMBER OF PAGES 88 |
| | 16. PRICE CODE |

| | | | |
|---|---|---|---|
| 17. SECURITY CLASSIFICATION OF REPORT Unclassified | 18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified | 19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified | 20. LIMITATION OF ABSTRACT UL |

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18 298-102

**Approved for public release; distribution is unlimited.**

# META ANALYSIS ON HIGH QUALITY RECRUITING ENLISTMENTS


Yeon Chang Chung
Captain, Korean Army
B.A., Korea Military Academy, 1987


Submitted in partial fulfillment
of the requirements for the degree of

**MASTER OF SCIENCE IN OPERATIONS RESEARCH**

from the

**NAVAL POSTGRADUATE SCHOOL**
**September 1995**

Author: Chung Yeon Chang

Yeon Chang Chung

Approved by: Soyoungsohn

So Young Sohn, Thesis Advisor

Harold J. Larson

Harold J. Larson, Second Reader

P. Purdue

Peter Purdue, Chairman
Department of Operations Research

# ABSTRACT

The success of the U. S. military recruiting depends not only on recruiting efforts but also on the labor market conditions. In this thesis, the econometric literature of military recruiting analysis based on historical data from FY81 to FY89 is reviewed. The random effects meta analysis models are used to examine the systematic variation in high quality enlistment elasticities obtained over different studies with respect to advertising, recruiter forces, and unemployment rate, respectively.

The results of the meta analysis show that (1) the Army advertising turns out to be more effective than that of the other military services; (2) the models with the recruiting goal factor tend to have significantly smaller recruiting elasticities with respect to advertising and recruiter forces than their counterpart; (3) the unemployment rate elasticities do not vary significantly over different studies; (4) the Army advertising elasticity on the high quality contract is relatively low compared to the unemployment rate and the recruiter elasticities; (5) in terms of cost, the military expenditure for the recruiters appears to be more cost-effective in producing quality recruits than advertising expenditure, when the cumulative long-run effects for advertising were ignored. These findings are expected to give some insights into future military recruiting.

## TABLE OF CONTENTS

# LIST OF TABLES

## LIST OF FIGURES

# EXECUTIVE SUMMARY

As a result of the disintegration of the Soviet Union, the U.S. has begun a large scale drawdown of the size of its military forces. This downsizing translates into fewer recruits to be enlisted into the military. A smaller number of recruits may appear to require a reduced recruiting effort. However, in fact, having to recruit fewer people means that the U.S. Military services must be selective about who can enlist into the services.

In order to support each service's recruiting mission, a considerable amount of funds has been allocated to military recruiting. During FY93, the services spent approximately $1.5 billion to recruit personnel. In an era of decreasing budgets, the services must ensure that they reap the full benefit of their spending. Efficient allocation of the recruiting efforts has been one of the major concerns of each military service's recruiting command. In addition, recruiting is sensitive to fluctuations in labor market conditions such as recruiting goal, unemployment rate, relative military pay to civilian wage, prime target market population, and the services' competition.

There have been numerous studies that analyzed the effects of both military recruiting efforts and the labor market conditions on high quality enlistments. Most studies employ econometric models and the study results are summarized in terms of the elasticities of the high quality contracts with respect to advertising, the number of recruiters, and the unemployment rate. Elasticities are defined that how the high quality enlistment responds to a 1 percent change in advertising, the number of recruiters, and the unemployment rate.

However, many differences have been observed among the study results. In this thesis, the military recruiting literature is reviewed and random effects meta analysis models are used to analyze the systematic variation in the published elasticities of high quality contracts with respect to advertising, the number of recruiters, and the unemployment rate. Although advertising, the number of recruiters, and the unemployment rate were treated relatively homogeneously, compared to the other variables such as incentives and pay, high quality elasticities estimated with respect to these components vary over different study results.

In a random effects model, the elasticity involved in each study is considered as an outcome of a random sample from a population. Various recruiting studies are viewed as imperfect replications of one overall unplanned experiment. Each elasticity is assumed to be random and a linear model for the elasticity is fitted against some factors such as service, goal, and competition to identify sources of the systematic variation. Sixteen study results are selected for the random effects meta analysis. The study results used in the random effects model have some common features as well as differences. The common features are, first, the relatively homogeneous measurement of advertising, recruiter effort, and unemployment rate; secondly the time period (1989-1991) based on which the high quality contract elasticity of each component is estimated; thirdly, the availability of standard error of the estimated elasticity. However, these 16 studies differ in terms of targeting military service(Army and other services), inclusion of other service's competition, and inclusion of recruiting goal in the model. In view of these different features, three factors (Service,

Competition, and Goal) were chosen. Ten out of sixteen studies are for the Army recruiting analysis, fourteen studies use a goal factor in their analyses, and eight studies include competition factor in their analyses. The maximum likelihood (ML) method is used to estimate the effects of these factors on each elasticity.

**The significant findings are outlined as follows:**

Significant service and goal effects are found in advertising; Army advertising turns out to be more effective than that of the other military services while the models with the recruiting goal component tend to have significantly smaller recruiting elasticity. Goal turns out to be significantly dependent on the variation in the recruiter elasticity. None of the three factors turns out to be significantly dependent on the variation in the unemployment rate elasticity.

When both competition and goal factors are included in the Army recruiting analysis, the 95% confidence intervals centered at the mean for the high quality enlistment elasticities with respect to advertising, recruiter, and unemployment rate are (-0.02, 0.15,0.32), (-0.04, 0.43, 0.89), and (0.32, 0.50, 0.68). These intervals can be interpreted as follows. As advertising expenditure increases by 1%, it is expected that high quality enlistments would increase by 0.15% on average and by a maximum of 0.32% with 95% confidence. Likewise, as the number of recruiters increases by 1%, it is estimated that high quality enlistments would increase by 0.43% on average and by a maximum of 0.89% with 95% confidence. That is, in order to increase the high quality enlistments by 1% (about 492 personnel), at least an additional 2.85 million dollars (FY95 constant) should be spent for

the Army advertising, and an additional minimum amount of 1.87 million dollars (FY95 constant) in the recruiter expenditure would be needed. With respect to unemployment rate, as unemployment rate rises by 1%, it is expected that high quality enlistments would increase by 0.50% on average and by a maximum of 0.68% with 95% confidence.

**The recommendations for future recruiting analysis are briefly outlined below.**

The three factors and the case studies used in this thesis may not be exhaustive. One of the additional factors to be further considered in the meta analysis for the military recruiting models is different estimation methods, provided that there are sufficient replicated studies in which the same estimation method is used.

In the analysis of random effects meta analysis models, it was assumed that the results of each published study are independent of each other. However, it is possible that some study results might be related due to the estimation of slightly different models on the same data set. Although neglecting the potential dependence in the random effects meta analysis models does not appear to have a significant impact on the inference procedure, a sensitivity analysis based on Monte Carlo simulation is recommended for further study.

In analyzing a set of three elasticities (advertising, recruiter, and unemployment rate), a multivariate analysis could be applied. However, in general, the covariance matrices for these estimated elasticities are not reported in the literature and subsequent analysis is infeasible. All studies reviewed in this thesis assume constant elasticity, which does not necessarily reflect the dynamic feature of military recruiting. It is recommended that authors report the covariance matrix of the estimated elasticities and a time varying

coefficient method be used to estimate elasticities for future research in the area of high quality military recruiting.

## ACKNOWLEDGMENTS

First of all, I would like to extend my sincere appreciation to Dr. So Young Sohn and Dr. Harold J. Larson for their excellent guidance and patience. Without their encouragement and guidance toward the completion of this thesis, I would have never completed the work I had started.

I would also like to thank my classmates for their assistance during my research. Most of all, I wish to express my love and thanks to my wife who provided me with support and encouragement during the past twenty seven months.

# I. INTRODUCTION

## A. BACKGROUND

With the advent of the all-volunteer force (AVF) in 1973, the United States ended its heavy reliance on the draft to provide first-term enlisted personnel and turned to economic incentives to attract the approximately 300,000 new recruits it requires each year. Much initial skepticism existed over the viability of the AVF, but recruiting during the early period was surprisingly successful [Ref.32: p.47]. During the 1970s, the Military was generally able to obtain the number of individuals required, but the quality of those recruits, as measured by high school completion and aptitude scores, has varied considerably. In 1979, for example, only 16% of the individuals enlisting in the Army had high school diplomas [Ref.6: p.261]. The Army's experience was particularly dismal, and the poor quality of accessions threatened the AVF.

However, the quality of recruits increased substantially throughout the 1980s. The significant rise in high quality enlistments in the Military during the 1980s was partly attributed to economic conditions that were highly favorable to recruiting, as well as the large increases in relative pay and high civilian unemployment rate during that period. Particularly, the Army experienced the greatest improvement in high quality enlistments during the early 1980s, in part because of the Army College Fund (ACF). In addition, the introduction of the New GI Bill program (NGIB) in 1986 made all four services' recruiting

successful. The NGIB program, which has undergone several phases, has permitted the Military to supplement the educational benefits to high quality recruits in hard-to-fill skills [Ref.33]. An important development during the 1980s was a renewed emphasis on educational benefits to attract high quality enlistments. However, continued growth in the economy, a declining youth population, and budgetary pressures contributed to difficulties for military recruiting during the late 1980s.

U.S. Military services have experienced a period of enormous turbulence and uncertainty since 1990. The major impact of the end of the Cold War, coupled with the sound defeat of Iraq by coalition forces in 1991 resulted in the required reduction of military strength. This reduction can be achieved by either taking an accession-heavy-approach or an across-the-board approach [Ref.14]. In the accession-heavy-approach, major reduction is achieved at the entry level of accession, and it results in a top-heavy force that can be inefficient and costly. Therefore, the across-the-board approach that takes reduction from different ranks is, in general, preferred. The increased accession goal for the Army active duty force in 1993 is a good example of the preference of the across-the-board to accession-heavy-approach. Public perception of smaller armed forces, however, makes recruiting more difficult. The analysis of the military recruiting process and the effects of the recruiting effort should help to plan effective recruiting under such adverse circumstances.

## B. PROBLEM STATEMENT

There have been numerous studies that analyzed the effects of both recruiting efforts (advertising, number of recruiters, recruiting goal, and so on) and the labor market conditions on enlistments (Goldberg [Ref.10]; Hanssens and Levien [Ref.13]; Daula and Smith [Ref.6]; Polich, Dertouzos and Press [Ref.23]; Kostiuk and Follmann [Ref.16]; Dertouzos [Ref.7]; Dertouzos and Polich [Ref.8]; Goldberg [Ref.11]; Warner [Ref.33]; Kearl, Horne and Gilroy [Ref.15]; Goldberg [Ref.12]; Lovell and Morey [Ref.17]; Lovell, Morey and Wood [Ref.18]; Morey [Ref.19]; Charnes et al. [Ref.5]; Berner and Daula [Ref.2] ). Most studies employ econometric models, while some adopt data envelopment analysis. In general, study results are summarized in terms of the elasticities of the high quality contracts with respect to recruiting efforts and labor market conditions. Elasticities are defined as percentage changes in the high quality enlistment in response to a percentage change in recruiting efforts or labor market conditions. But, there are many differences among the study results. These differences can cause confusion to recruiting practitioners.

## C. OVERVIEW OF THESIS

### 1. Objective

The main purpose of this thesis is to analyze the systematic variation in the published elasticities of recruiting efforts using a random effects meta analysis model [Ref.9&28]. The findings are expected to give some insights into future military recruiting.

### 2. Organization

Chapter II describes the background of military recruiting. Chapter III reviews the previous study results concerning high quality recruiting analyses. Chapter IV introduces a meta analysis that provides a tool to combine different study results. Based on the meta analysis method, average elasticities of high quality contracts are calculated with respect to some recruiting efforts and market conditions. In Chapter V, the actual data analysis is performed to examine the variation over the study results. Finally, in Chapter VI, the results are discussed and some recommendations are made for further research.

# II. MILITARY RECRUITING

## A. OVERVIEW

Since the advent of the AVF in July 1973, the U.S. military services have employed several marketing strategies to meet various quantity and quality goals. As opposed to the conventional markets, the product to be sold is the entry level positions for each military occupational skill (MOS), and the main focus of the marketing strategy lies in filling the quotas for these positions with high quality applicants.

Military recruiting is processed at several different hierarchies. For example, the U.S. Army Recruiting Command (USAREC) had 4 recruiting brigades, with control over 40 recruiting battalions, with an average 90 recruiters assigned to each battalion in FY94. Its primary mission is to recruit men and women to fill the enlisted ranks of both active duty and U.S. Army Reserve (USAR) units. Each recruiting battalion consists of 3 to 7 recruiting companies that supervise the recruiting activities of 6 to 10 recruiting stations. The recruiting stations (1390 stations in FY94) are supervised by a senior noncommissioned officer who, together with one or more recruiters, conduct the actual recruiting activities. Despite the increasing role of women in the military, actual recruiting activity for active duty primarily targets males from 17 to 21 years of age with no prior military service.

## B. THE IMPORTANCE OF HIGH QUALITY ENLISTMENTS

As a result of the disintegration of the Soviet Union, the U.S. has begun a large scale drawdown of the size of its Military forces. For instance, the Army will reduce the active component from 12 to 10 divisions, and the Army's active end strength from 540,000 to 495,000 by the end of fiscal 1996. In 1989, the Army had 18 active divisions with an active end strength of 770,000. When this reconstitution is completed, the Army will have been reduced by 36% from its 1989 structure [Ref.29]. Further downsizing of active Army Forces could be met partly through reducing the number of young men and women accessed into the forces. This downsizing translates into fewer numbers of recruits to be enlisted into the military annually. A smaller number of recruits may appear to require a reduced recruiting effort. However, in fact having to recruit fewer people means that the U.S. military services must be more selective about who can enlist into the services. Moreover, the ever-increasing sophistication of weapons and support systems, together with intelligent employment of these systems, means that only the best and brightest be allowed to enter the force.

"The quality of military personnel is at an all-time high. All commanders attribute the success of DESERT STORM to quality of the people and their training ." [1]

---

[1]John, Christopher, Assistant Secretary of Defense, Force Management and Personnel, in : Memorandum for the Secretary of Defense, OPERATIONS DESERT SHIELD/STORM, LESSONS LEARNED, unpublished, not numbered, 1991.

This statement suggests that further success for the U.S.Armed Forces will depend on effective recruitment policies and training methods.

Recruits must meet a variety of physical, mental, and moral qualifications. The Armed Services Vocational Aptitude Battery (ASVAB) is the examination given to all prospective members of the armed forces. The ASVAB is a series of ten tests[2], each yielding a separate score. One combination of scores on the ASVAB serves as the Armed Forces Qualification Test (AFQT). The AFQT serves as a screening test. It eliminates those who are not qualified to serve. The AFQT score is derived from a composite of a candidate's scores on the Arithmetic Reasoning, Word Knowledge, Paragraph Comprehension, and Numerical Operations section of ASVAB. Table 1 provides a break-down of AFQT Categories with corresponding percentile score ranges. A high quality enlistment is defined as a recruit who has a valid high school diploma, or is a senior in the process of obtaining one, and who scores in categories I through IIIA on the AFQT. Figure 1 shows the strong relationship between aptitude measure (AFQT) and military hands-on performance test scores for all 30 specialities on which data were collected. To the extent that AFQT is a valid predictor of performance, people with higher AFQT scores should outperform their counterparts with lower AFQT scores at each military job experience level [Ref.21].

---

[2] General Science, Arithmetic Reasoning, Word Knowledge, Paragraph Comprehension, Numerical Operations, Coding Speed, Auto & Shop Information, Mathematics Knowledge, Mechanical Comprehension, and Electronics Information.

**Table 1. AFQT CATEGORIES AND CORRESPONDING PERCENTILE SCORE RANGES**

| AFQT CATEGORY | PERCENTILE SCORE RANGE |
|---|---|
| I | 92 - 99 |
| II | 65 - 92 |
| IIIA | 50 - 64 |
| IIIB | 31 - 49 |
| IV | 10 - 30 |
| V | 1 - 9 |

(Source : [Ref.20: p.24])

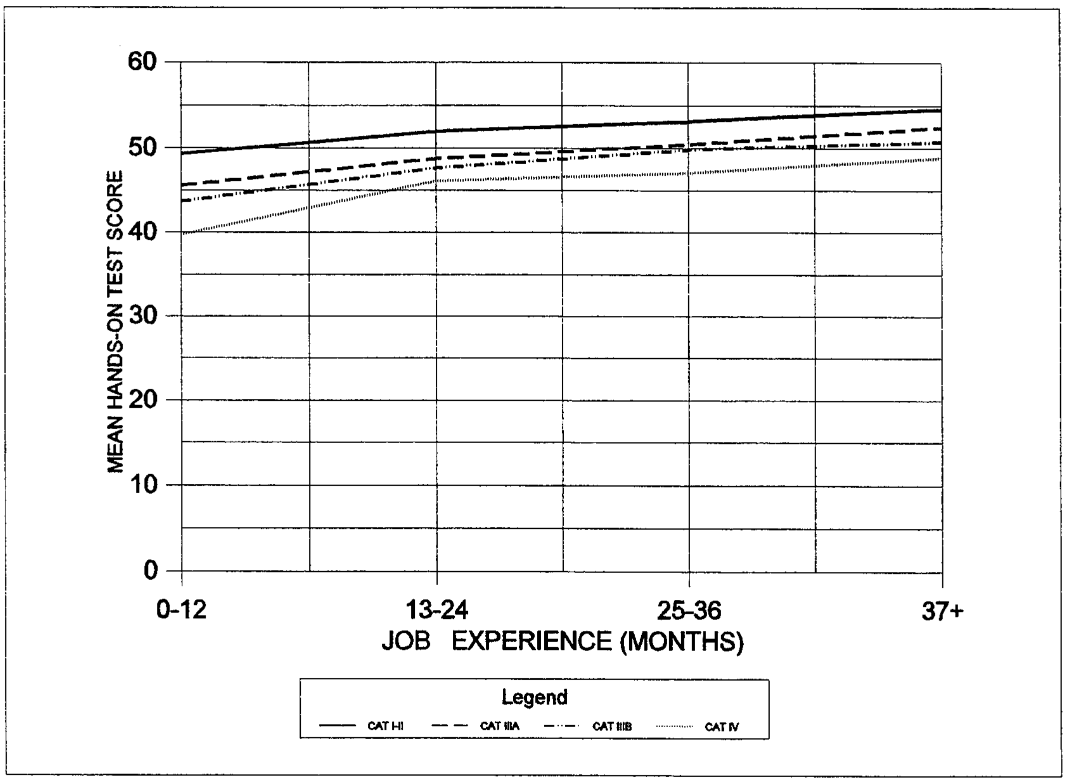


Figure 1. AFQT Test Scores vs Job Experience

Prime target market recruits are considered to be 17 to 21 year old male, high school diploma graduates. In general, the prime target market population can be either at school or at work. Many of them might be interested in finding a job, or consider changing to a new job. In view of several education programs and incentive polices that the military offers for those who are looking for a job, a military position in the services can be an attractive alternative to a civilian job. From a labor economic perspective, an individual enlists when the military compensation package meets or exceeds his current wage. In addition to the civilian job competition, there is inter-service competition among different military services in terms of attracting the prime target market population.

The quality of recruits increased substantially throughout the 1980s (see Table 2) as reflected by an increase in the proportion of high school graduates and by rising scores on the AFQT. This contrasts sharply with the late 1970s recruit population that consisted of 54% high school graduates with only 25% scoring above the 50th percentile on the AFQT, for the Army. Recently (FY93 and FY94), recruiting efforts were less successful than the 1980s, due partly to the diminishing male youth population and growing economy. Sustained economic growth resulted in low unemployment rates and higher real earnings for youth, therefore more youths have recently had better job opportunities than were available during the early 1980s. Another reason for successful recruiting is the substantial cut in the Military recruiting budget. For the Army, for instance, between 1986 and 1990, funding for recruiting (measured in 1989 dollars) declined by 22%. This significantly reduced funds allocated for important recruiting initiatives such as Army educational benefits

**Table 2. PERCENT OF HIGH QUALITY RECRUITS**

| Service | '81 | '82 | '83 | '84 | '85 | '86 | '87 | '88 | '89 | '90 | '91 | '92 | '93 | '94 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Navy | 41 | 45 | 54 | 54 | 51 | 48 | 52 | 52 | 48 | 55 | 62 | 66 | 64 | 63 |
| Marine Corps | 39 | 43 | 48 | 49 | 53 | 65 | 66 | 61 | 63 | 62 | 67 | 70 | 66 | 68 |
| Army | 29 | 39 | 45 | 47 | 52 | 54 | 58 | 52 | 55 | 62 | 78 | 78 | 66 | 66 |
| Air Force | 51 | 56 | 66 | 70 | 69 | 71 | 76 | 82 | 82 | 85 | 85 | 85 | 79 | 80 |
| DoD Total | 39 | 45 | 52 | 53 | 56 | 57 | 60 | 61 | 58 | 64 | 72 | 74 | 67 | 68 |

(Source: NavyTimes/March 6,1995)

and advertising. Moreover, the cut restricted availability of a particularly popular enlistment incentive - the two-year enlistment tour.

In an era of decreasing budgets, the services must ensure that they reap the full benefit of their spending. Efficient allocation of the recruiting effort has been one of the major concerns of each military service's recruiting command. Individual components of the recruiting budget known to have a significant impact on enlistment include advertising, recruiter efforts, and special targeted incentives. In addition, recruiting is sensitive to fluctuations in labor market conditions such as recruiting goals, unemployment rate, relative military pay to civilian wage, size of the prime target market population, and competition from other services. In the following section, each component of recruiting efforts and labor market conditions is reviewed briefly.

## C. MAJOR FACTORS AFFECTING HIGH QUALITY ENLISTMENTS

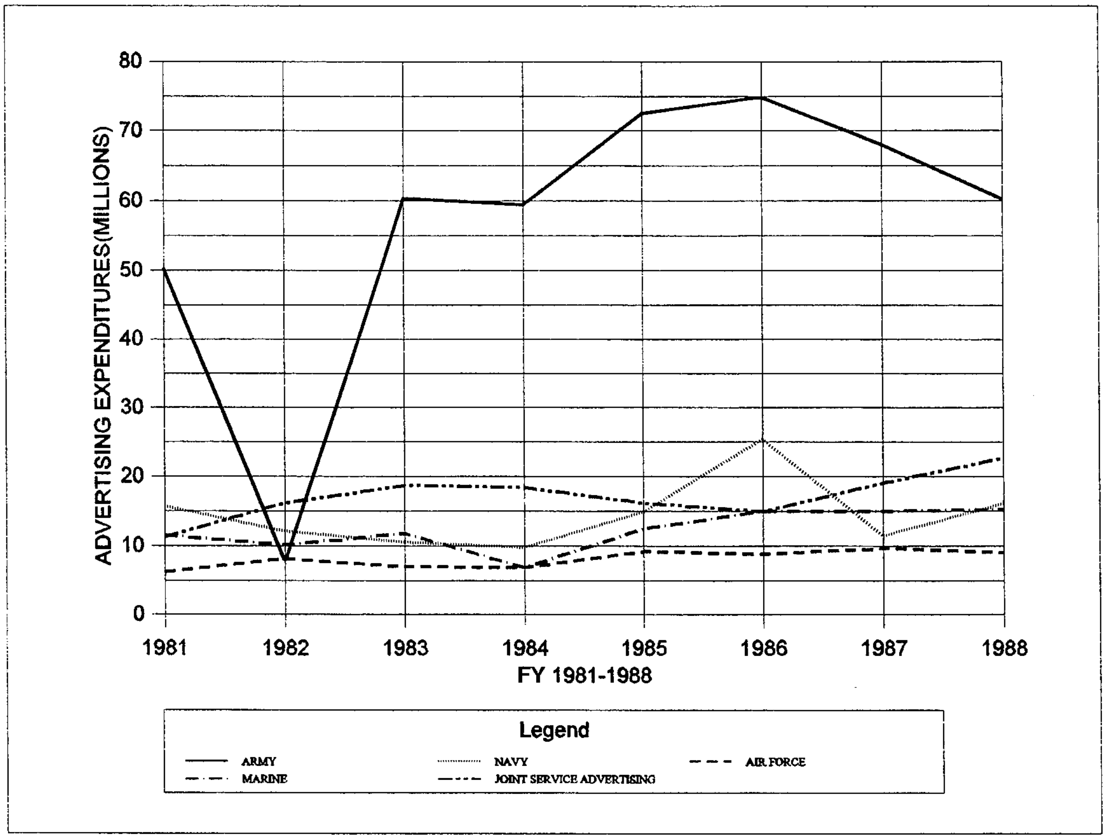


Figure 2. Advertising Expenditures (millions of 1982 dollars)

### 1. Advertising

Advertising is one of the primary tools used by the U.S. Military to achieve its enlistment goals. Most recruiting advertising is done through national, or centralized media purchases: network television, network radio, national magazines, and direct mail. The services typically use these media to disseminate messages intended to enhance their images and to describe the general character of the jobs and training they offer. In addition, each service carries out a local advertising program (daily, weekly, high school newspapers

and locally purchased spot radio advertising), through which local districts promote more immediate themes -such as current job opportunities, enlistment options, and the names and telephone numbers of recruiters who can be connected by prospective recruits. Local advertising is also cited as a means of supplementing the national campaigns. Local advertising, in all, accounts for about 10 to 15 percent of the total advertising budget. Figure 2 shows advertising expenditures for FY1981-1988, in 1982 real dollars. Army advertising expenditures comprised a high and rising share of advertising . Although Army advertising expenditures declined nearly 10 percent during the 1987-1988 period, they rose by 50% between 1981 and 1986 [Ref.33: p.49-51].

### 2. Recruiters

One can expect the number of recruiters to have a large and significant effect on the number of enlistments since recruiters have direct and continual contact with prospective applicants. Figure 3 shows that the number of active recruiters increased gradually over the decade (FY80 - FY89) from approximately 4,800 to nearly 5,800 in the Army [Ref.12]. Recruiters contact many potential enlistees and stimulate interest in military services. The performance of recruiters contribute to the high quality enlistments. The recruiter force is an important tool for increasing high quality enlistments.

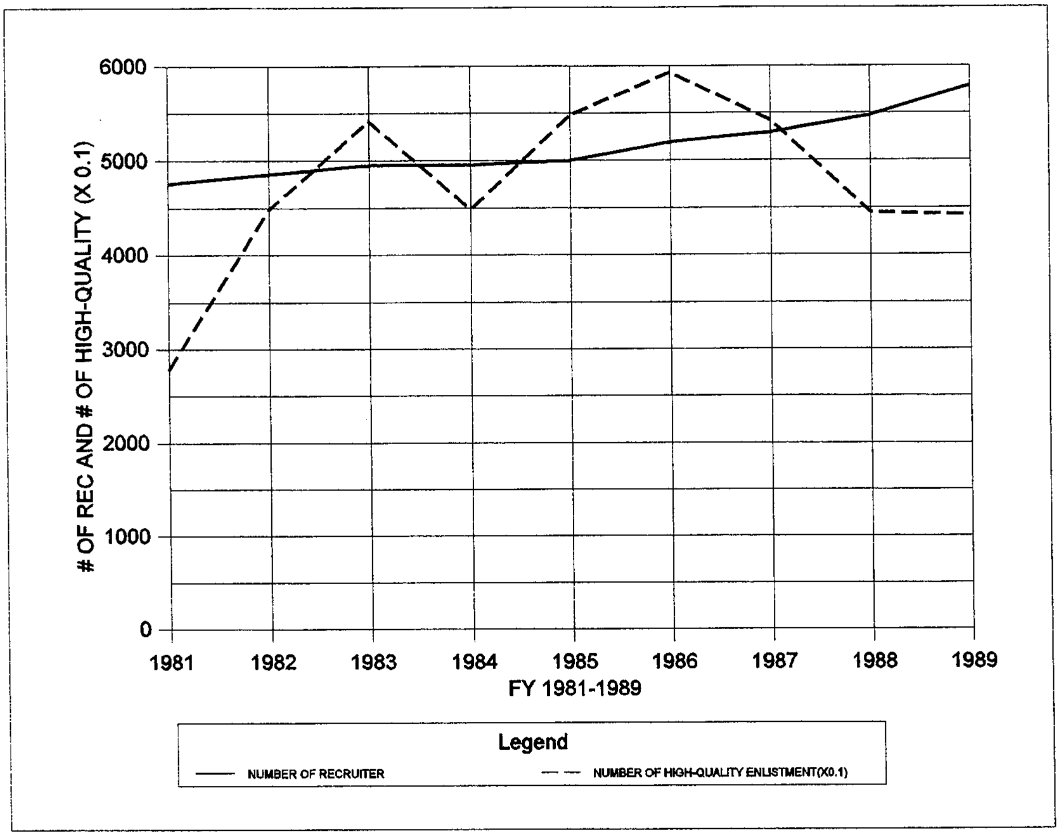


Figure 3. Number of Recruiters vs Number of High Quality Enlistment(×0.1)

### 3. Unemployment Rate and Relative Military Pay

The supply of high quality enlistments has been sensitive to fluctuations in the youth labor market. The analysis of labor market conditions must begin with the two basic economic forces that determine military enlistments: (1) military pay relative to civilian wages and (2) the civilian unemployment rate.

From Figure 4, one may trace the decline in high quality recruiting of the late 1980s in the Army, for instance, largely due to declining male (16-21years) civilian unemployment rate [Ref.12]. Between 1981 and 1983, an increasing civilian unemployment rate also

contributed to a military favorable recruiting environment. During this period, the dearth of civilian job opportunities increased the attractiveness of the military service.

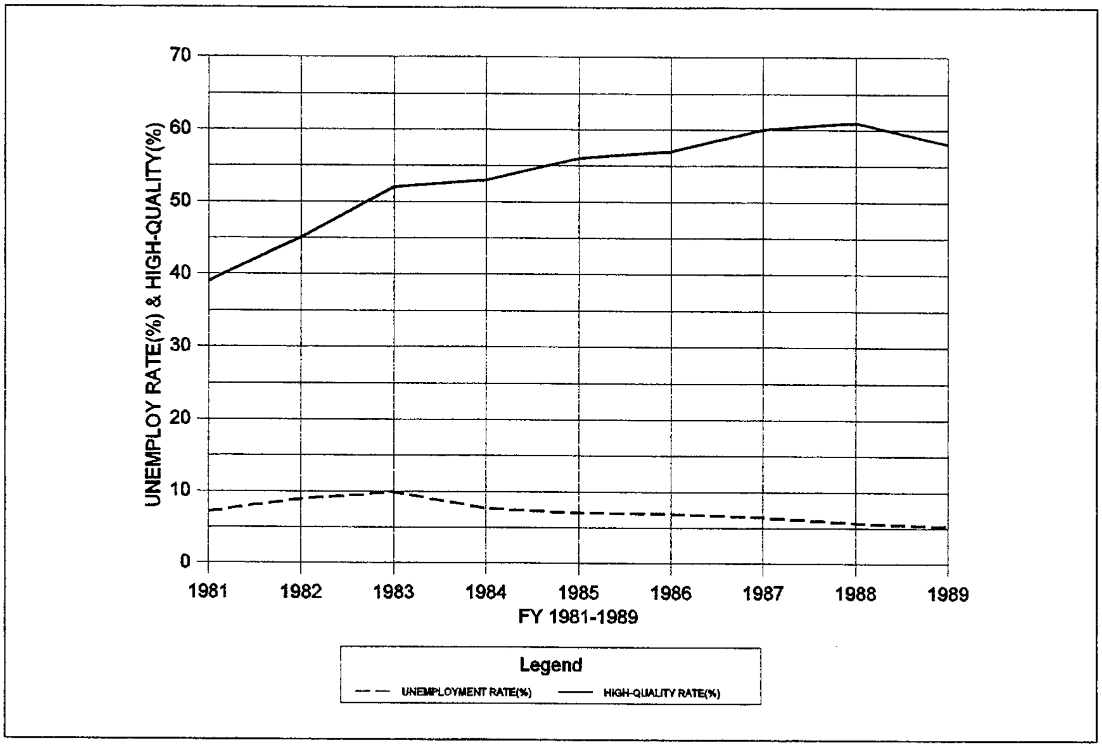


Figure 4. Unemployment Rate vs High Quality Rate

**Table 3. CIVILIAN PAY(CP) VS RELATIVE MILITARY PAY RATE(RMPR) FOR THE ARMY**

| | '81 | '82 | '83 | '84 | '85 | '86 | '87 | '88 | '89 |
|---|---|---|---|---|---|---|---|---|---|
| CP($) | 29468 | 30607 | 31408 | 32701 | 33669 | 34346 | 35010 | 35804 | 36590 |
| RMPR | 1.057 | 1.158 | 1.166 | 1.141 | 1.141 | 1.169 | 1.167 | 1.165 | 1.189 |

Relative military pay rate(RMPR) is the ratio of the present value of Regular Military Compensation (RMC) for a typical enlistee over a four-year period to the present value of full-time equivalent earnings of 18-21 year-old civilian males. Data on military pay and

promotion rate were obtained from the Department of Defense (Office of Military Compensation) [Ref.12]. Since FY1982, military pay has maintained a rough parity with civilian wages(see Table 3).

### 4. Goal

Enlistment goals are a primary factor shaping the actual number of enlistments into the armed forces. Such goals, which reflect the services' demand for new entrants, are driven largely by force level authorizations and personnel turn-over. Because goals are a potential demand constraint, success or failure in recruiting is measured more appropriately

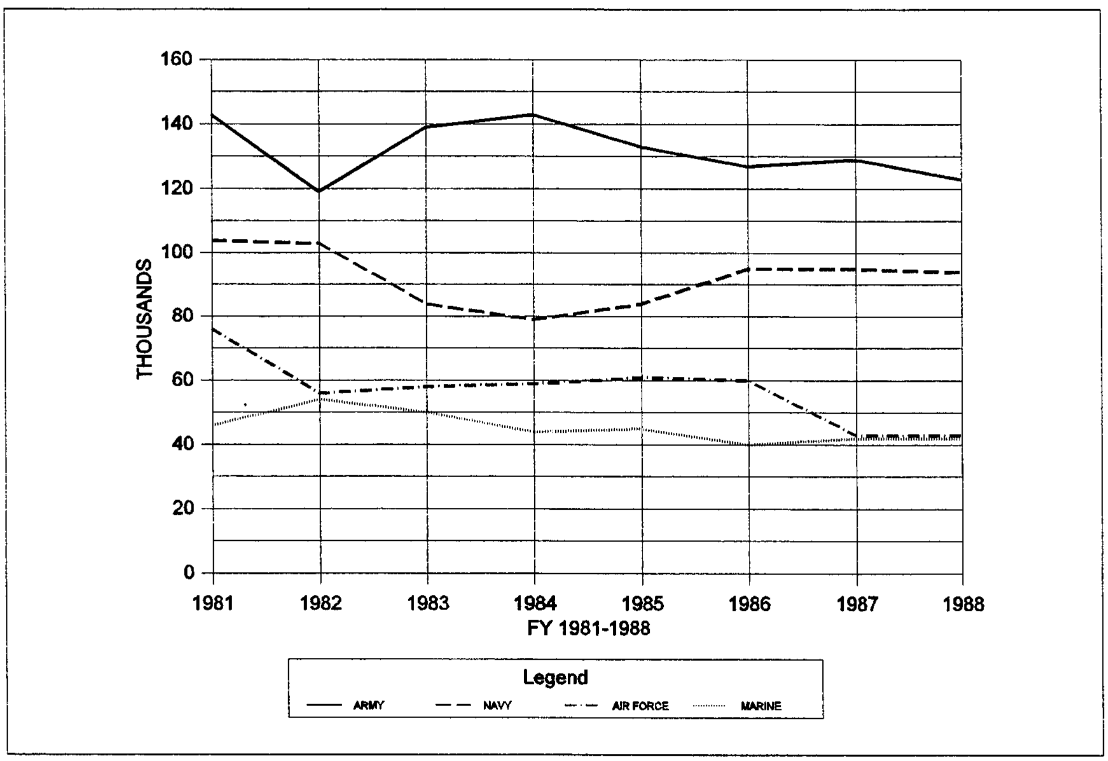


Figure 5. High Quality Contract Goals

by how well the services accomplish their goals than by absolute numbers of enlistments. In general, recruiters are given monthly quotas or goals by their Recruiting Commands. Figure 5 displays the services' total contract enlistment goals for FY1981 - 1988 [Ref.12: p.49-50]. They move quite differently over the period. The Army, after dropping its goal in 1982, expanded its goal considerably during 1983-1985, and then reduced it during 1986-1988. In particular, the Army has provided detailed goals, the so-called Mission Box, to recruiters by enlistment category since FY1986 [Ref.33]. This had a strong positive effect on high quality enlistments.

There are many studies that analyzed these factors (i.e., advertising, recruiters, unemployment rate, goal, etc) in relation to the fluctuation in high quality enlistments. In the following Chapter, results of these studies are summarized.

# III. REVIEW OF RECRUITING ANALYSIS

## A. ECONOMETRIC MODELS

**Daula and Smith** [Ref.6] estimated several high quality enlistment models using a time series and cross sectional data set of monthly observations on Army's 54 recruiting battalions data from October 1980 through June 1983. Their models were different from previous studies of Army enlistments in three major ways. First, the specification was generally more comprehensive than existing models. Second, they improved the measurement of several important variables using new data and methodology. Third, they tested the usual assumption that all observations on high quality enlistments are supply constrained.

The authors considered national advertising separately from local advertising, where the national advertising was measured in terms of the impression incurred made, while the local advertising was measured in terms of the actual expenses. Recruiter experience, as well as the number of production recruiters, was used to find the recruiter elasticity. Additionally, several incentive related variables were included, as were environmental conditions. They estimated log-linear enlistment models, since ordinary least squares are potentially subject to simultaneity bias. To avoid bias they adopted a limited-information approach, using instrumental variable estimation.

Daula and Smith found that demand (in the form of the enlistment goals assigned to

recruiter) does affect the number of enlistments obtained. Enlistment models without the enlistment goals may not provide accurate forecasts, especially when these goals are changing. Therefore, the pooled sample model, without the enlistment goals or other service enlistments, was substantially less accurate than the complete specification. But, they used manufacturing wages as their measure of civilian opportunities. The use of these variables would be less of a problem if they were highly correlated with the wage opportunities available to potential recruits. Unfortunately, that would cause the parameter estimates in the military labor supply models to be statistically inconsistent due to errors-in-variables.

**Polich, Dertouzos and Press** [Ref.23] evaluated the effects of expanded cash bonuses authorized by Congress (the Uniformed Services Pay Act of 1981) to attract highly qualified young people into military service. Two new bonus programs were tested in the Army from July 1982 through June 1984. These data included military data enlistment rates during the test period and one-year base period. Different levels of bonus programs were included in the model along with the number of recruiters and advertising expenses. Advertising was measured in terms of national as well as local expenditure.

For labor market conditions, the unemployment rate and the civilian wage of production workers in manufacturing industries were included, along with recruiting goals for high and low quality recruits. Recruiting elasticities were obtained based on a two-stage estimation procedure. They showed that bonuses can have a substantial effect on recruiting. Bonuses are a very flexible policy tool, by design. Without altering the fundamental structure or level of military compensation, bonuses can be quickly altered when shortfalls

appear in specific personnel categories. Also, bonuses are a useful option for management of enlistment flows and for overcoming personnel shortages in critical skills.

**Dertouzos** [Ref.7] analyzed the effects of advertising on recruiting and quantitative estimates of the relative effectiveness of Army, Navy, Air Force, Marine Corps, and joint advertising programs. The cost effectiveness of military advertising was investigated, based on additional econometrics analysis of observed monthly enlistment outcomes, advertising pattern, missions, demographic conditions, and recruiter allocations for all four services conducted in 210 markets during FY84, the year of the Advertising Mix Test. Total service-specific enlistment rates (contracts per 17-21 year old) will be a log-linear function of that services' recruiters, other services' advertising, and joint advertising. Other recruiting components included were; the number of recruiter quotas per capita, per capita income and unemployment rates. National military data advertising dollars were expressed as a weighted sum of current and past expenditures, under the assumption that the effects diminish by 40 percent monthly.

Elasticities were estimated based on seemingly unrelated regressions. He found that joint advertising program was estimated to have a positive effect for all four services, and the estimates of own-service effects were not significant for the Navy or Marine Corps.

**Dertouzos and Polich** [Ref.8] developed a model to analyze the Army advertising effects on high quality enlistment, utilizing unique information describing monthly Army advertising expenditures and advertising patterns for a three year period from July 1981 to June 1984 at the level of the military entrance processing station (MEPS). Most recruiting

advertising is done through national or centralized media purchases (i.e., network television, network radio, national magazine, and direct mail), as well as local advertising purchases (daily, weekly and high school newspapers, local radio advertisings, magazine advertisings).

High quality enlistment elasticities, with respect to several recruiting components and environmental variables, were obtained using a nonlinear three-stage least squares method. This provided consistent estimates for all the underlying structural parameters representing recruiter behavior, general supply relationships, and advertising effects. The print media appear to be the most cost effective advertising outlet. In particular, magazine advertisements are superior to other forms of national advertising in terms of the short-run elasticities.

Results strongly support the conclusion that advertising expenditures substantially affect short-run enlistment behavior, and expansion of the Army advertising program during a given month can induce increases in high quality contracts for as long as six months. Statistical results indicate that national magazine and local newspaper purchases are the most effective in promoting enlistments. National radio and network TV also have considerable effects.

**Goldberg** [Ref.11] estimated the effects of the Army's educational benefits program on the supply of Army GSMA (high school Graduate or Senior Male, test score category I-IIIA) enlistments using regression analysis with monthly battalion-level data for the period FY81-89 (5184 observations). He did try to take into account the changes in MOS coverage.

Estimates were obtained using the fixed effects technique, focusing on educational benefit variables and taking into account both the level of benefits and the coverage of the

programs. He found that ACF benefits reduce the term-of-service selected and that it is increased by bonuses. ACF benefits and bonuses affect the term-of-service (TOS) choice made by enlistees. These effects should be taken into account by policy makers when they assess the cost and benefits of the programs.

**Warner** [Ref.33] dealt with the inter-service (Army, Navy, Air Force, and Marine Corps) advertising competition issue on quarterly data for the 41 Navy Recruiting Districts (NRD) during the period 1981-1987 (1148 observations). Two log-linear regression models (one with trend and the other without time trend) were fitted to each service using a fixed effect regression estimator. Each recruiting related variable was measured as the deviation in a given quarter from the average value of the variable in the given NRD over the 28 quarter sample period.

The findings had confirmed the importance of educational benefits and high quality enlistments were responsive to civilian unemployment rate, relative military pay, and recruiting variations (recruiters, advertising, and educational benefits). Regarding the estimated effects of advertising, the Army is the only service for which a consistently significant positive effect of advertising is maintained. Regarding inter-service relationships, all three services (except Marine) were estimated to benefit from increases in the recruiter strengths of the other services. Army enlistments apparently were independent of the other services advertising expenditures. Larger advertising expenditures by the other services, primarily by the Army, were estimated to reduce both Navy and Air Force enlistments.

However, this information might be less reliable than the cross-service recruiter

effects, because of the crudity and potential endogeniety of the advertising data. Recruiters and advertising have substantially lower marginal cost, that is, they remain the most cost-effective means of varying high quality enlistments. Both means of expanding enlistments were considerably cheaper than general pay increases and educational programs. Consequently, the services should rely on general pay increases only to solve recruiting shortfalls such as the situation that prevailed during the early 1980s.

**Kearl, Horne and Gilroy** [Ref.15] used the generalized least squares method to estimate the high- quality enlistment supply model to correct heteroscedasticity. They used quarterly data for the five major Army brigades of the country, from the first quarter of 1981 through the first quarter of 1990. The dependent variable was the number of high quality male enlistment contracts per 10,000 male youths. The explanatory variables in the model included the relative pay, the number of production recruiters per 10,000 male youths, the total advertising budget, the real discounted cost of ACF benefits, a dichotomous variable representing the introduction of the Montgomery GI Bill (effective July 1985), and the unemployment rate of males who are older than 16 years.

A summary of their study results is as follows. Youth labor market conditions, proxied by the total male unemployment rate, have an important effect. Relative pay also has a sizable enlistment effect. Recruiters and advertising variables also have major impacts on enlistment supply. However, the enlistment effect of the ACF is relatively small.

Alternative specifications of the model include two other variables: enlistment propensity and recruiting goals. Propensity would be particularly important for a regional

model, since regions exhibit sizable differences in taste (The strongest propensities are in the Southeast and Southwest). But propensity is highly correlated with other exogenous variables. Including recruiting goals in the regression equation also affected the parameter estimates. The increasing recruiting goals could meet accession requirements without cost. Therefore, including both recruiting goals and propensity caused the estimated effects of all other variables to fall.

**Goldberg** [Ref.12] used the 41 NRDs annual data for FY81-89 and Army recruiting battalion monthly data set (FY1981-89) to fit four services' high, as well as low, quality contract production. Elasticities were based on estimates of time-series cross-section (TSCS) and time-series (TS) regression models. Separate enlistment models were estimated for non-prior service male high school diploma graduates in GSMA and GSMB. A log-linear model was used in the estimation. Each model included a basic set of economic factors (relative military pay, unemployment rate) and service specific variables (recruiters, goals, policies). The regression coefficients were partial elasticities, i.e., the percentage that enlistments change when a supply factor increases by one percent and all other factors are held fixed. For each service, both a combined annual time-series and cross-section model and a monthly time-series model were estimated based on the fixed effects procedure.

Goldberg found that substantial enlistment supply is effected for relative military pay, unemployment rate, recruiters and GI Bill benefits for all services. This study yielded strong evidence that ACF benefits affect GSMA enlistments. Bonuses for 3-year enlistment increased GSMA by about 5% in July 1984 when the program was introduced nationally.

The TS models should be used for short-run forecasting. It appeared that the best estimates of elasticities can be obtained with monthly rather than the annual district level models.

**Lovell and Morey** [Ref.17] employed a translog cost function to efficiently allocate incentive expenditure, so that various MOS quotas could be satisfied. They estimated the translog incentive cost function for 21 MOS. The seemingly unrelated regression technique was used to estimate the model parameters based on FY81-86 data from the U. S. army Recruiting Command, which allocated over $1 billion for special incentives to selected recruits. The dependent variable was the number of high quality male enlistment contracts and the explanatory variables in the model included incentive unit costs (the size of the eligible population, relative pay, advertising expenditure), enlistment outside the MOS and environmental variables. The incentives consist of enlistment bonuses (EBs) up to $8k and the ACF with differing educational benefits for 2, 3 or 4 year terms. The total incentive cost, in FY86 dollars, was approximately $1.17 billion.

Lovell and Morey developed and illustrated an econometrics approach for estimating the cost-efficient allocation of consumer incentives. They found that the key Infantry MOS (with more than 25% of all dollars) was quite well managed. The ACF incentive should have received 5.5% more of the budget than it had in fact received. However, for some other MOS's the total predicted allocative inefficiency was relatively high. This might be due to the fact that the other skills have much higher market values in the civilian sector than does Infantry, suggesting that the Army need not offer such generous enlistment incentives for those other MOS's. Also, ACF tends to attract short-term

enlistments. Within both the ACF and the EB systems different benefits are available with different terms of service, suggesting that the disaggregation of each monetary incentive option may be useful.

**Berner and Daula** [Ref.2] proposed a high quality enlistment model in which the goal for the quality contract is endogenized. Using Current Population Survey data (CPS), they developed a more accurate estimate of the alternative wage faced by young men. In constructing this alternative wage series, they were concerned not only with measurement error, but also with the possibility of simultaneity between the wage variable and military labor supply.

They employed statistical specifications, so called, three regime switching simultaneous-equations in order to allow varying behavior across recruiting environments that reflect the asymmetric incentives faced by recruiters. Three regimes are followed in terms of the battalion's contract achievement conditions:

1) far below the mission in a given month;
2) close to mission achievement;
3) already virtually assured of meeting its mission as it enters the final days of a month.

They used a log-linear model. Elasticities were obtained using 55 monthly Army recruiting battalion level data sets as well as monthly information on the economic environment and demographics during the period from October 1980 to January 1990. They had presented strong evidence that the institutional environment, in which Army

recruiting takes place, necessitates a switching equation specification of the aggregate labor-supply process. In addition, they showed that the procedures for allocating recruiting goals for high quality soldiers result in these goals being endogenous to the supply process. They also found that labor supply to the Army was positively related to relative pay and unemployment rate, and that marginal recruits appear to be very sensitive to monetary incentives such as EBs. They found that relative pay is overemphasized during the goal-setting process and that unemployment rate is underemphasized.

## B. OBSERVATION

As reviewed, most recruiting studies share the same purpose: to estimate high quality contract elasticities with respect to several recruiting related components. However, the estimated elasticities vary considerably over the different studies, possibly due to several different factors associated with each study. In general, the recruiter elasticity was hypothesized as the highest among the recruiting resource elasticities. In most studies, the estimate was based on the number of production recruiters, while one study (Daula and Smith [Ref.6]) used the recruiter experience as an additional variable to represent the recruiter effort.

The advertising elasticity was measured in terms of either the total expenditure or the impressions generated. The elasticity can be measured in terms of the national and local advertising which can be further decomposed into media type (TV, radio, and print). In view of the limited information available for the impressions data and relatively small amount of local advertising, most studies employ total advertising expenditure data to estimate the elasticity. However, in some studies (Dertouzos [Ref.7]; Dertouzos and Polich [Ref.8]) in which the main objective is to analyze the effect of advertising, elasticities are obtained with respect to each media type.

As incentives, the Army has offered the ACF with various options since the initial test program year in 1981. During FY1981, all services participated in a program that systematically varied the kind of education benefits program that could be offered in different recruiting districts. Starting in FY82, there was a similar test conducted by the

Army only. Prior to FY86, Army enlistees ineligible for ACF benefits and enlistees into the other services continued to be eligible for basic Veteran's Educational Assistance Program (VEAP) benefits. A NGIB was then passed by Congress in 1985 which provides such enlistees with better educational benefits than those available in the VEAP. In order to estimate incentive elasticities, some studies use the total expenditure related to incentives while the others used dummy variables to represent different levels of incentives utilizing the experimental data (Daula and Smith [Ref.6]).

Enlistment goal has been considered one of the most influential predictors for high quality contracts. However, some studies did not include the goal variable in the model. Recently, Berner and Daula [Ref.2] treated it as an endogenous variable.

Unemployment rate was treated as relatively homogeneous in many recruiting analyses. In estimating the relative military pay elasticity, the entry level military pay (E1-E2) was used in comparison to the manufacturing sector civilian pay. In some studies (Polich, Dertouzos and Press [Ref.23]; Dertouzos [Ref.7]; Dertouzos and Polich [Ref.8]), the relative pay was replaced with the civilian wage.

The prime target market population is one of the important labor market variables. In place of the prime target market population, some authors (Daula and Smith [Ref.6]) used "qualified military available" defined as the prime target market population consisting of those who are mentally and physically healthy and score in the top 50th percentile of AFQT, with a high school diploma. Inter-service competition related components such as other services advertising and goals were often deleted in the recruiting models used.

In sum, consistently analyzed recruiting-related components are advertising, the number of recruiters and the unemployment rate. Although these variables were treated relatively homogeneously compared to the other variables such as incentives and pay, estimated elasticities of high quality enlistments with respect to these components vary over different studies conducted.

In the following chapter, a meta analysis is introduced to summarize these differences.

# IV. META ANALYSIS

Meta analysis is a quantitative method that is used to summarize results from a series of related studies. The meta analysis process of cleaning up and making sense of research literature not only reveals the cumulative knowledge that is there, but also provides clearer directions about what the remaining research needs are. Meta analysis has been applied to the integration of literature in all areas of research such as the behavioral and social sciences, psychology, education, biology, medical science, and physical science since Gene V. Gass published the first journal article on meta analysis in 1976 [Ref.14]. In this thesis, meta analysis is used as a major tool to integrate the military high quality recruiting literature.

An important question in meta analysis is the consistency of study results. If each implementation of a new experimental treatment produces the same effect, it is sensible to summarize the entire stream of studies by a single common-effect size estimate. However, if the study results are inconsistent, the meta-analyst's task becomes more complicated. The hierarchical model provides a useful framework for addressing the problem of components of variation in meta analysis [Ref.3]. This hierarchical model enables the meta-analyst (a) to estimate the average effect size, such as the elasticity across a set of studies; (b) to estimate the variance of the effect-size parameters (as distinguished from the variance of the estimates); (c) to pose and test a series of linear models to explain variation

in the effect-size parameters; (d) to estimate the residual variance of the effect-size parameters for each model; and (e) to use information from all studies to derive empirical Bayes estimates of each study's effect.

General procedures for the hierarchical linear model for meta analysis involve the following areas:

1) Effect-Size Estimate
2) Level-1 (Within-study) Model
3) Level-2 (Between-studies) Model
4) Combined Model
5) Estimation.

## A. GENERAL PROCEDURES FOR THE HIERARCHICAL MODEL

### 1. Effect-size estimate

A meta-analyst rarely has access to raw data from each study. Instead, subject data from each study are summarized by a statistic. This statistic characterizes the magnitude of an effect, or the strength of association between variables. This statistic, $\hat{\beta}_i$, is denoted as the "effect-size estimate" for study *i*. $\hat{\beta}_i$ could be a mean difference, correlation coefficient or elasticity, and so on. The statistic, $\hat{\beta}_i$, may be viewed as an estimator for the corresponding population parameter, $\beta_i$.

## 2. Level - 1 (within-study) model

The level - 1 model is

$$\hat{\beta}_i = \beta_i + \xi_i \qquad \text{for studies } i = 1, \ldots, N, \tag{1}$$

where $\xi_i$ is the sampling error associated with $\hat{\beta}_i$. We assume $\xi_i$'s are independently and normally distributed with zero mean and variance $\hat{v}(\hat{\beta}_i)$, where $\hat{v}(\hat{\beta}_i)$ is the sampling variance of $\hat{\beta}_i$ and $\xi_i$ is independent of the unknown $\beta_i$.

## 3. Level - 2 (between-studies) model

The true unknown - effect size, $\beta_i$, depends on study characteristics and a random error:

$$\begin{aligned}\beta_i &= \gamma_0 + \gamma_1 x_{i1} + \gamma_2 x_{i2} + \ldots + \gamma_m x_{im} + \delta_i \\ &= \gamma_0 + \sum_{k=1}^{m} \gamma_k x_{ik} + \delta_i ,\end{aligned} \tag{2}$$

where $x_{i1}, \ldots, x_{im}$ are study characteristics;

$\gamma_0, \ldots, \gamma_m$ are regression coefficients; and

$\delta_i$ are independently and normally distributed with zero mean and common variance $\sigma^2$.

**4. Combined model**

Substituting equation (2) into equation (1) yields

$$\hat{\beta}_i = \gamma_0 + \sum_{k=1}^{m} \gamma_k x_{ik} + \delta_i + \xi_i , \tag{3}$$

where $\hat{\beta}_i$ is normally distributed, that is, $\hat{\beta}_i \sim N(\ \gamma_0 + \sum_{k=1}^{m} \gamma_k x_{ik},\ \sigma^2 + \hat{v}(\hat{\beta}_i)\ )$.

Note that model (3) is called a random effects model. When $\delta_i$ is omitted from model (3), this model becomes a fixed effects model.

**5. Estimation**

Because each $\hat{\beta}_i$ will be known from each study result $i$, there is only one variance component to be estimated, $\sigma^2$. Given a maximum likelihood estimate of $\sigma^2$, the Level-2 coefficients (the $\gamma$s) are estimated by means of weighted least squares where the weights are $(\sigma^2 + \hat{v}(\hat{\beta}_i))^{-1}$.

## B. RANDOM EFFECTS MODEL

### 1. Heteroscedastic Maximum Likelihood (HML) estimation

A fixed effects meta analysis has often been used in marketing analysis to find significant factors associated with varying study results (Assmus, Farley, and Lehmann [Ref.1]; Szymanski, David and Paul Busch [Ref.30]; Rust, Lehmann, and Farley [Ref.26]). In a fixed effects model, estimated study results (e.g., elasticities), are combined and used as a dependent variable that is related to some independent variables that may cause the variation in different study results. The coefficients associated with each independent variable have been typically estimated using an ordinary least square (OLS) method.

However, the accuracy of estimated study results often varies, which violates the homogeneous assumption of the OLS method. Recently, Chandrashenkran and Walker [Ref.4] employ a heteroscedastic maximum likelihood estimation (HMLE), which is a maximum-likelihood-based estimation procedure that explicitly corrects for heteroscedasticity. The HMLE enhances the utility of meta analysis as an integrative tool for marketing research by providing a method to overcome the problem of heteroscedasticity, an important threat to the validity of meta-analytic findings. Heteroscedasticity impairs OLS estimates by reducing the efficiency and, consequently, the power of OLS to detect variables that may moderate the theoretical relationship of interest. Heteroscedasticity has potentially serious implications for theoretical inferences drawn from the results of a meta analysis that uses OLS as the analytic framework. In a

heteroscedastic environment, the OLS estimator will be unbiased and consistent, but it will also be inefficient and its variance estimator will be biased and inconsistent. Further, the inefficiency and variance bias will increase as heteroscedasticity becomes more severe. HMLE will produce unbiased, consistent, and the most efficient estimators among the class of unbiased estimators. Besides explicitly correct for heteroscedasticity, HMLE will generally be more efficient and powerful than OLS [Ref.4]. However, in general, the results obtained from the fixed effects model are only applied to those studies included in the analysis.

### 2. Random effects meta analysis model

In a random effects model [Ref.27], the elasticity involved in each study is considered as an outcome of a random sample from a population. The result of the random effects model can then be applied to any study that falls in the same population. In this thesis, various recruiting studies are viewed as imperfect replications of one overall unplanned experiment. Each elasticity is assumed to be random, however, part of the variation can be explained by some candidate factors. The random effects linear model for the elasticity is then fitted against some factors and is used to identify sources of systematic variation. Structural models employed in many econometric analyses ($i = 1, \ldots, N$) may not be exactly identical, however, the reduced form of each study $i$ would be close to the following:

$$\ln H_{ij} = \beta^i_0 + \beta^i_A \ln A_{ij} + \beta^i_R \ln R_{ij} + \beta^i_U \ln U_{ij} + \ldots + \epsilon_{ij}, \qquad (4)$$

where $j$ is the unit of case study $i$;

$H_{ij}$ is the $j$th observation of the high quality contract in study $i$;

$A_{ij}$ is the $j$th observation of the advertising expenditure in study $i$;

$R_{ij}$ is the $j$th observation of the number of production recruiters in study $i$;

$U_{ij}$ is the $j$th observation of the unemployment rate in study $i$;

$\beta^i_0$ is the intercept coefficient of study $i$;

$\beta^i_k$ is the high quality elasticity with respect to component $k$ obtained from study $i$, $k = A, R, U$;

$\epsilon_{ij}$ is the random error with $E(\epsilon_{ij}) = 0$ and $V(\epsilon_{ij}) = \tau_i^2$.

It is assumed that $\beta^i_k$ is random and most variation can be explained by some factors $x_{ik}$ related to each study $i$. In other words,

$$\beta_k = x_k \gamma_k + \delta_k \qquad (5)$$

for $k = A, R, U$, where $\beta_k$ is an $N \times 1$ vector of $\beta^i_k$ and $x_k$ is an $N \times m$ matrix consisting of factors $x_{ik}$ related to the variation of $\beta^i_k$'s. $\gamma_k$ is an $m \times 1$ vector of coefficients and $\delta_k$ is an $N \times 1$ vector of independent random errors that takes into account the remaining variation of $\beta^i_k$'s. We assume $\delta_k \sim N(0, \sigma^2_k I_N)$. Since $\beta^i_k$ is unobservable, the estimated

elasticity, $\hat{\beta}^i_k$, obtained from each study $i$, can replace $\beta^i_k$. As a result, estimation error $\xi_\kappa$ which is independent of $\delta_k$ is added to equation (5):

$$\hat{\beta}_k = x_k \gamma_k + \delta_k + \xi_k \tag{6}$$

It is further assumed that $\xi_k$'s are independent of each other. In most cases, estimated elasticity ($\hat{\beta}^i_k$) and standard error of $\hat{\beta}^i_k$ (se( $\hat{\beta}^i_k$)=$\sqrt{\hat{\upsilon}(\hat{\beta}^i_k)}$ ) are obtained based on a large sample (a combined cross section and time series data set). Therefore, $\delta_k + \xi_k$ would follow $N(0, v_k)$ where the $N \times N$ diagonal matrix $v_k$ has diagonal values $\sigma^2_k + \hat{\upsilon}(\hat{\beta}^i_k)$'s. That is, $\hat{\beta}^i_k \sim N(x_k\gamma_k, v_k)$. Since $\hat{\beta}$ and $\hat{\upsilon}(\hat{\beta}^i_k)$ are available from each recruiting study $i$, when $\sigma^2$ is known, $\gamma_k$ can be obtained using a weighted least square estimator(WLS), $\hat{\gamma}_k = (x_k' v_k^{-1} x_k)^{-1}$ $(x_k' v_k^{-1} \hat{\beta}^i_k)$. However, quite often $\sigma^2$ is unknown and can be estimated using the maximum likelihood (ML) method which maximizes the following log likelihood function $L_k$:

$$L_k = -0.5\sum_{i=1}^{N} \ln(2\pi\ (\sigma^2_k + \hat{\upsilon}(\hat{\beta}^i_k))) - 0.5\sum_{i=1}^{N} \frac{(\hat{\beta}^i_k - x_{ik}\gamma_k)^2}{(\sigma^2_k + \hat{\upsilon}(\hat{\beta}^i_k))} \tag{7}$$

The resulting WLS estimator for $\hat{\gamma}^w_k$ can be expressed as $(x_k' \hat{v}_k^{-1} x_k)^{-1} (x_k' \hat{v}_k^{-1} \hat{\beta}_k)$, where $\hat{v}_k$ consists of diagonal elements, $\hat{\sigma}^2_k + \hat{\upsilon}(\hat{\beta}^i_K)$. The estimated variance of $\hat{\gamma}^w_k$ is $(x_k' \hat{v}_k^{-1} x_k)^{-1}$. When the sample size, $N$, is large, asymptotic inferences regarding $\gamma_k$ can be

made based on $\hat{\gamma}_k^w \sim N(\gamma_k, (x_k'\hat{v}_k^{-1}x_k)^{-1})$.

To test $H_0 : \gamma_k = 0$ for all $m$ elements, an $F$ statistic with $m$ and $N - m$ degrees of freedom for numerator and denominator, respectively, can be used when sample size $N$ is large. When a single element of $\gamma_k$ is subjected to test, a $t$ statistic can be used with $N - m$ degrees of freedom.

# V. DATA ANALYSIS

## A. ACQUISITION OF DATA

Sixteen study results are selected from the previous econometric analyses described in the earlier section: 1 from (Dertouzos and Polich [Ref.7]); 8 from (Warner [Ref.33]); 3 from (Kearl, Horne and Gilroy [Ref.15]); and 4 from (Goldberg [Ref.12]). Description of the labeling of each study is given in Table 4. The selection criteria for these sixteen study results are as follows: (1) the target dependent variable is the high quality enlistment; (2) the advertising elasticity is measured in terms of the expenditure; (3) the recruiter elasticity is estimated based on the number of production recruiters.

**Table 4. DESCRIPTION OF EACH STUDY USED IN META ANALYSIS**

| | | |
|---|---|---|
| 1 | WNT | Warner (90) Navy model with time trend variable |
| 2 | WN | Warner (90) Navy model without time trend variable |
| 3 | WFT | Warner (90) Air Force model with time trend variable |
| 4 | WF | Warner (90) Air Force model without time trend variable |
| 5 | WMT | Warner (90) Marine Corps model with time trend variable |
| 6 | WM | Warner (90) Marine Corps model without time trend variable |
| 7 | KHG | Kearl, Horne and Gilroy (90) Army model without goal and propensity variables |
| 8 | KHGP | Kearl, Horne and Gilroy (90) Army model with propensity variable |
| 9 | KHGGP | Kearl, Horne and Gilroy (90) Army model with goal and propensity variables |
| 10 | DP | Dertouzos and Polich (89) Army model (National advertising elasticity is used.) |
| 11 | GOLD1D | Goldberg (91) Army cross section and TS model estimated based on DMDC data |
| 12 | GOLD2D | Goldberg (91) Army time series model estimated based on DMDC data set |
| 13 | GOLD1A | Goldberg (91) Army cross section and TS model estimated based on USAREC data |
| 14 | GOLD2A | Goldberg (91) Army TS model estimated based on USAREC data set |
| 15 | WAT | Warner (90) Army model with time trend variable |
| 16 | WA | Warner (90) Army model without time trend variable |

Table 5 displays the estimated high quality contract elasticities with respect to advertising expenditure, recruiter effort, and unemployment rate as well as their standard errors.

**Table 5. FACTORS AND ELASTICITIES**

| i | Study | Army | Comp | Goal | $\beta^i_A$ / se( $\beta^i_A$) | $\beta^i_R$ / se( $\beta^i_R$) | $\beta^i_U$ / se( $\beta^i_U$) |
|---|---|---|---|---|---|---|---|
| 1 | WNT | 0 | 1 | 1 | 0.015 / 0.008 | 0.412 / 0.047 | 0.477 / 0.024 |
| 2 | WN | 0 | 1 | 1 | -0.001 / 0.0070 | 0.459 / 0.047 | 0.441 / 0.022 |
| 3 | WFT | 0 | 1 | 1 | -0.034 / 0.0150 | -0.045 / 0.050 | 0.203 / 0.028 |
| 4 | WF | 0 | 1 | 1 | -0.038 / 0.0150 | -0.168 / 0.048 | 0.139 / 0.027 |
| 5 | WMT | 0 | 1 | 1 | -0.017 / 0.050 | 0.487 / 0.076 | 0.483 / 0.030 |
| 6 | WM | 0 | 1 | 1 | 0.001 / 0.0200 | 0.957 / 0.066 | 0.402 / 0.031 |
| 7 | KHG | 1 | 0 | 0 | 0.720 / 0.1080 | 1.150 / 0.095 | 0.650 / 0.071 |
| 8 | KHGP | 1 | 0 | 0 | 0.580 / 0.1060 | 0.680 / 0.138 | 0.650 / 0.069 |
| 9 | KHGGP | 1 | 0 | 1 | 0.430/ 0.1070 | 0.480 / 0.133 | 0.570 / 0.064 |
| 10 | DP | 1 | 0 | 1 | 0.0231/ 0.0044 | 0.542/ 0.064 | 0.512/ 0.107 |
| 11 | GOLD1D | 1 | 0 | 1 | 0.340 / 0.0436 | 0.160 / 0.080 | 0.430 / 0.040 |
| 12 | GOLD2D | 1 | 0 | 1 | 0.010 / 0.0076 | 0.290 / 0.216 | 0.720 / 0.075 |
| 13 | GOLD1A | 1 | 0 | 1 | 0.050 / 0.0058 | 0.150 / 0.031 | 0.590 / 0.018 |
| 14 | GOLD2A | 1 | 0 | 1 | 0.020 / 0.0119 | 0.350 / 0.330 | 0.760 / 0.126 |
| 15 | WAT | 1 | 1 | 1 | 0.103 / 0.0400 | 0.371 / 0.074 | 0.554 / 0.026 |
| 16 | WA | 1 | 1 | 1 | 0.198 / 0.0410 | 0.482 / 0.076 | 0.451 / 0.025 |

## B. FACTORS AND CASES IN RANDOM EFFECTS MODEL

Recruiting study results used in the random effects model have some common features as well as differences. The common features are, first, the relatively homogeneous measurement of advertising, recruiter effort, and unemployment rate; secondly the time period (1989-1991) based on which the high quality contract elasticity of each component is estimated; thirdly, the availability of standard error of the estimated elasticity. The results of studies differ in terms of the military service (Army, Navy, Air Force, Marine Corps), inclusion of other service's competition, and inclusion of recruiting goal. In view of these different features, the three factors which are reported in Table 6 in order to analyze the systematic variation in the elasticities are considered.

**Table 6. FACTORS IN THE RANDOM EFFECTS MODEL**

| Factor | Service | Competition | Goal |
|---|---|---|---|
| Level 1 | Army (1) | Included (1) | Included (1) |
| Level 2 | Other Service (0) | Not Included (0) | Not Included (0) |

When the study results in terms of the three factors with the two levels are summarized, there are eight possible combinations. However, only four out of the eight combinations have been employed in the studies analyzed. The simple means of the estimated elasticities for each combination are given in Table 7. The simple mean, however, does not reflect the differing accuracies associated with the estimates.

**Table 7. MEAN ELASTICITIES OF RECRUITING COMPONENTS**

| Case | Service | Comp | Goal | Freq | Mean($\hat{\beta}_A$) | Mean($\hat{\beta}_R$) | Mean($\hat{\beta}_U$) |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | na | na | na | na |
| 2 | 0 | 0 | 1 | na | na | na | na |
| 3 | 0 | 1 | 0 | na | na | na | na |
| 4 | 1 | 1 | 0 | na | na | na | na |
| 5 | 0 | 1 | 1 | 6 | -0.012 | 0.350 | 0.358 |
| 6 | 1 | 0 | 0 | 2 | 0.650 | 0.915 | 0.650 |
| 7 | 1 | 0 | 1 | 6 | 0.146 | 0.329 | 0.597 |
| 8 | 1 | 1 | 1 | 2 | 0.151 | 0.427 | 0.503 |

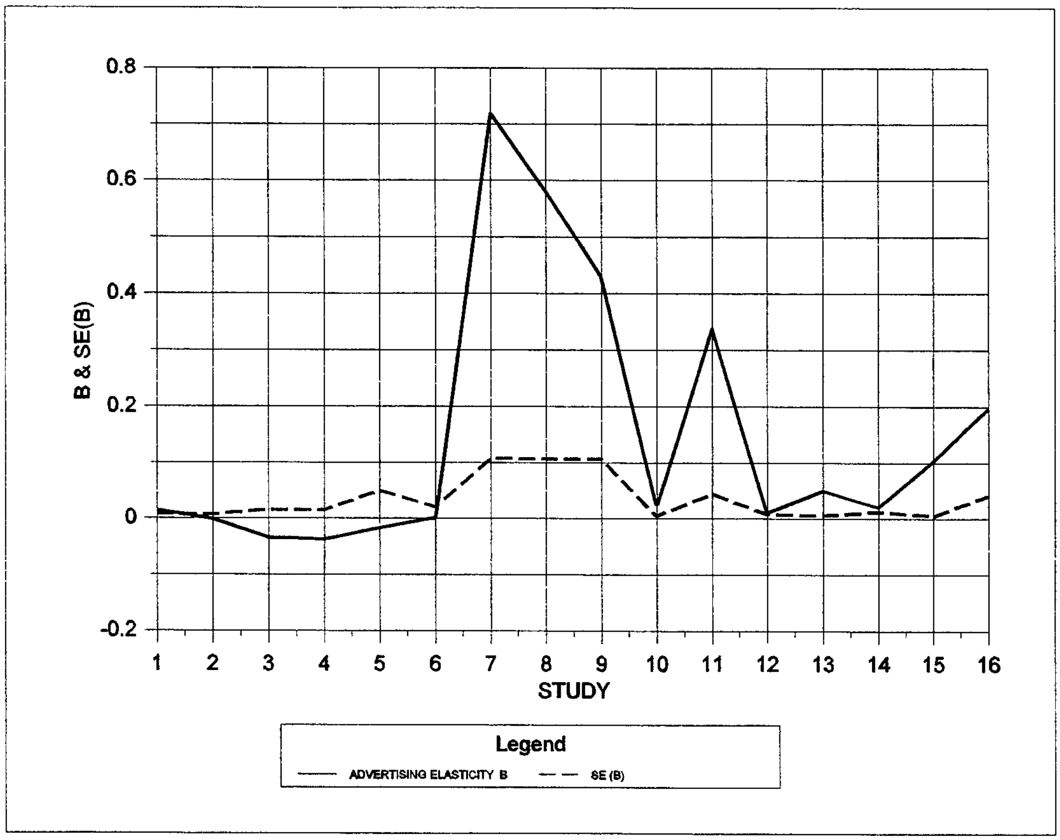


Figure 6. Estimated Advertising Elasticity (B) and SE(B)

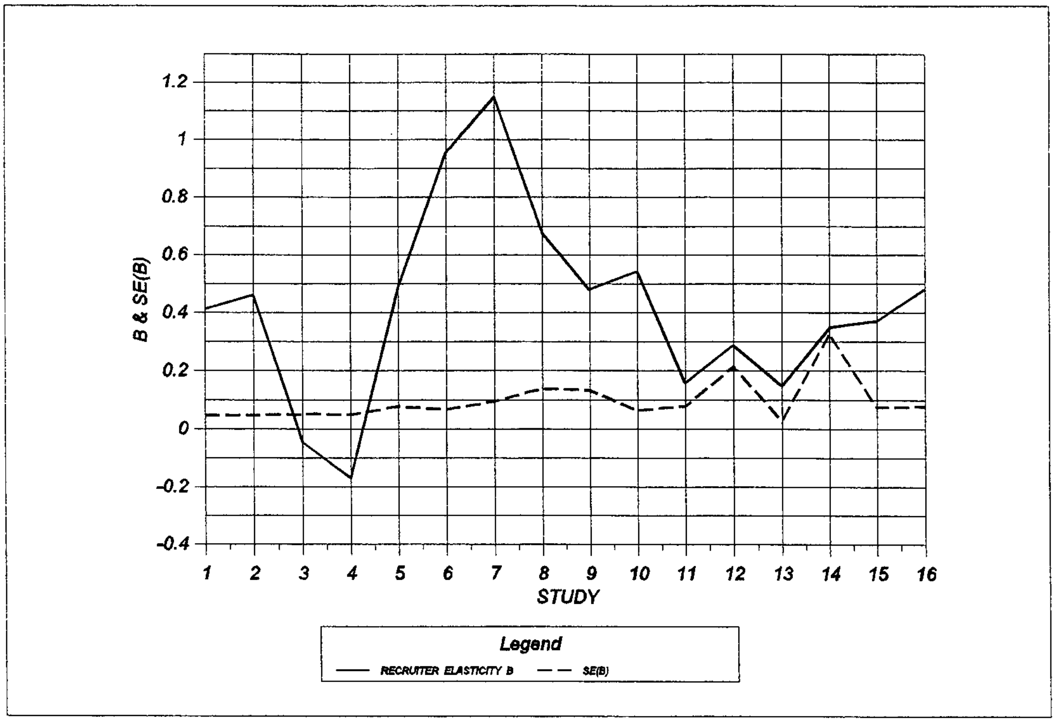


Figure 7. Estimated Recruiter Elasticity (B) and SE(B)

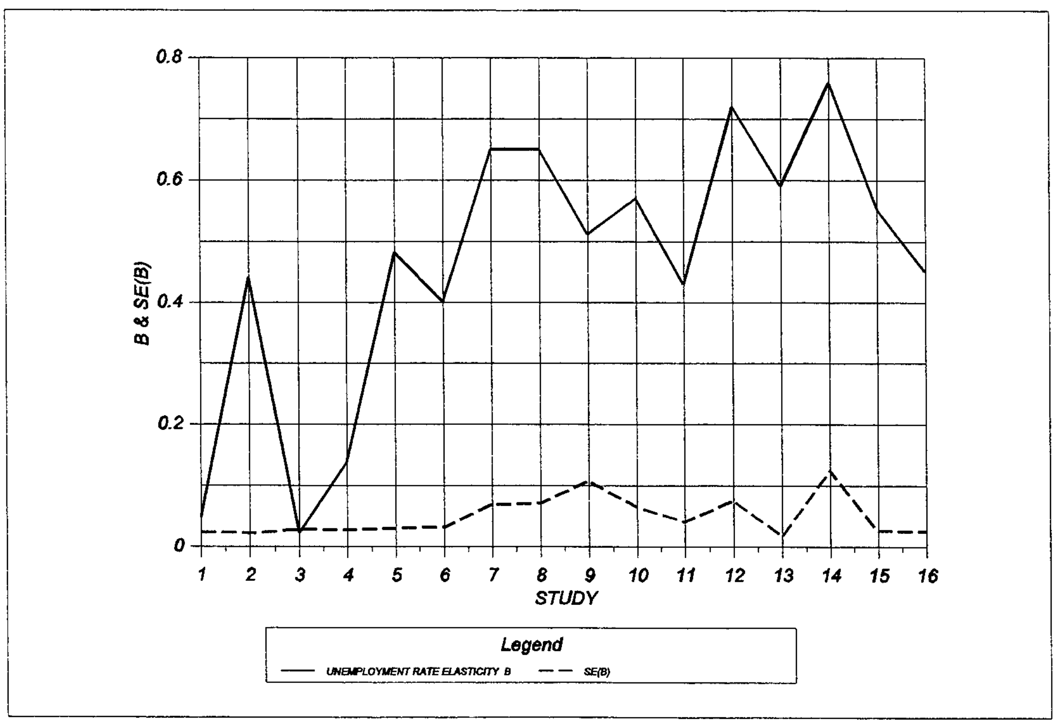


Figure 8. Estimated Unemployment Rate Elasticity (B) and SE(B)

In Figures 6-8 , estimated elasticities are plotted with associated standard errors for advertising, recruiter, and unemployment rate, respectively. Note that some of the outliers (e.g., negative elasticities or large positive elasticities) are accompanied by relatively large standard errors. Besides these apparent outliers, some variation is still observed.

## C. ESTIMATED MODELS

The random effects linear model for the elasticity is then fitted against the three factors and is used to identify significant sources of systematic variation. By applying equation (7) to the data set in Table 5, the ML estimators $\hat{\sigma}_k^2$'s for advertising, recruiter, and unemployment rate models are obtained as 0.00540196, 0.06807596, 0.010258, respectively. For this estimation, an optimization package GAMS program is used in Appendix A. This information is then used to find the WLS estimators of $\gamma$. It is interesting to compare WLS estimator, $\hat{\gamma}_k^w = (x_k' \hat{v}_k^{-1} x_k)^{-1}(x_k' \hat{v}_k^{-1} \hat{\beta}_k)$, to the OLS estimator, $\hat{\gamma}_k^o = (x_k' x_k)^{-1}(x_k' \hat{\beta}_k)$, and the HML estimator, $\hat{\gamma}_k^H = (x_k' H_k x_k)^{-1}(x_k' H_k \hat{\beta}_k)$, where $H_k = [\hat{v}(\hat{\beta}_k')]^{-1}$. The results of the WLS estimator $\hat{\gamma}_k^w$, $se(\hat{\gamma}_k^w)$'s and p-value are given in Table 8. The results of the OLS estimator are displayed in Table 9, while the corresponding information for the HML estimator is given in Table 10, respectively for three elasticity models. A copy of the SAS program used to obtain WLS estimator is in Appendix B.

**Table 8. WLS ESTIMATE $\hat{\gamma}_k^w$ AND SE ( $\hat{\gamma}_k^w$ )**

| | AD Expenditure | REC Effort | UNEM Rate |
|---|---|---|---|
| Factor | $\hat{\gamma}_A^w$ $se(\hat{\gamma}_A^w)$<br>P-Value | $\hat{\gamma}_R^w$ $se(\hat{\gamma}_R^w)$<br>P-Value | $\hat{\gamma}_U^w$ $se(\hat{\gamma}_U^w)$<br>P-Value |
| Intercept | 0.487 ( 0.147 )<br>0.0062 | 0.850 ( 0.332)<br>0.0251 | 0.505 (0.137)<br>0.0031 |
| Service | 0.162 ( 0.086 )<br>0.0846 | 0.080 ( 0.245)<br>0.7501 | 0.145 (0.096)<br>0.1574 |
| Competition | 0.052 ( 0.088)<br>0.5634 | 0.103 (0.252 )<br>0.6904 | -0.078 (0.100)<br>0.4519 |
| Goal | -0.551 (0.126)<br>0.0009 | -0.606 ( 0.262)<br>0.0391 | -0.070 (0.113)<br>0.5494 |

**Table 9. OLS ESTIMATE $\hat{\gamma}_k^o$ AND SE ( $\hat{\gamma}_k^o$ )**

| | AD Expenditure | REC Effort | UNEM Rate |
|---|---|---|---|
| Factor | $\hat{\gamma}_A^o$ $se(\hat{\gamma}_A^o)$<br>P-Value | $\hat{\gamma}_R^o$ $se(\hat{\gamma}_R^o)$<br>P-Value | $\hat{\gamma}_U^o$ $se(\hat{\gamma}_U^o)$<br>P-Value |
| Intercept | 0.487 ( 0.137 )<br>0.004 | 0.839 ( 0.323)<br>0.0234 | 0.505 (0.137)<br>0.0031 |
| Service | 0.163 ( 0.104 )<br>0.1423 | 0.076 ( 0.244)<br>0.7606 | 0.145 (0.104)<br>0.1873 |
| Competition | 0.005 ( 0.104)<br>0.9625 | 0.098 (0.244 )<br>0.6959 | -0.095 (0.104)<br>0.3800 |
| Goal | -0.504 (0.104)<br>0.0004 | -0.586 ( 0.244)<br>0.0335 | -0.053 (0.104)<br>0.6185 |

**Table 10. HML ESTIMATE $\hat{\gamma}_k^H$ AND SE ( $\hat{\gamma}_k^H$)**

| | AD Expenditure | REC Effort | UNEM Rate |
|---|---|---|---|
| Factor | $\hat{\gamma}_A^H$ $se(\hat{\gamma}_A^H)$ P-Value | $\hat{\gamma}_R^H$ $se(\hat{\gamma}_R^H)$ P-Value | $\hat{\gamma}_U^H$ $se(\hat{\gamma}_U^H)$ P-Value |
| Intercept | 0.490 ( 0.245) 0.0683 | 0.857 ( 0.491) 0.1066 | 0.515 (0.210) 0.0301 |
| Service | 0.158 ( 0.087 ) 0.0945 | 0.141 ( 0.290) 0.6347 | 0.135 (0.082) 0.1251 |
| Competition | 0.119 ( 0.087) 0.1963 | 0.196 (0.298 ) 0.5236 | -0.071 (0.092) 0.4536 |
| Goal | -0.619 (0.229) 0.0193 | -0.770 ( 0.417) 0.0898 | -0.078 (0.202) 0.7053 |

In terms of p-values from Tables 8-10, in general, WLS has the lower p-values of elasticities than those of elasticiticies in OLS and HML methods. The significant factors at level of 10% obtained based on the three different estimation methods are summarized in Table 11. Table 11 indicates that the recruiter effort and unemployment rate models share the same significant factors regardless of different estimation methods, while the OLS method provides slightly different results in the advertising expenditure model.

Since, the number of available studies in each category is not equal, $\hat{\gamma}_k$ does not necessarily represent the main effect on elasticity $k$ as in a balanced design. However, from Table 8, one can conclude that Army advertising elasticity is higher than that of the other military services, while the model that contains the goal variable provides lower

advertising elasticity than its counterpart on average at significance level $\alpha$=10%. For recruiter elasticity, there is a negative effect of goal factor. In other words, the models including the recruiting goal variable tend to result in smaller recruiter elasticity. None of the three factors considered has a significant effect on the unemployment rate elasticity, a weighted mean elasticity is obtained as 0.4797, where the weight is proportional to the inverse of the variance associated with each elasticity, $\hat{\sigma}_U^2 + \hat{\upsilon}(\hat{\beta}_U^i)$.

**Table 11. COMPARISON OF SIGNIFICANT FACTORS AMONG DIFFERENT METHODS**

| | WLS significant factors | OLS significant factor | HML significant factors |
|---|---|---|---|
| AD Expenditure | Goal, Service | Goal | Goal, Service |
| REC Effort | Goal | Goal | Goal |
| UNEM Rate | None | None | None |

## D. DISCUSSION

In Figures 9-11, the WLS model based 95% confidence intervals for high quality elasticities with respect to advertising, recruiter, and unemployment rate are displayed, respectively. Note that cases 1 to 4 are extrapolated results. Case 8 which considers both competition and goal factors for the Army model is of particular interest. In this case, with respect to advertising and recruiter, the values of the 95% confidence intervals centered at the mean for the Army high quality enlistments elasticities are (-0.01732, 0.15023, 0.31777) and (-0.03766, 0.42639, 0.89044), respectively in Figures 9-10.

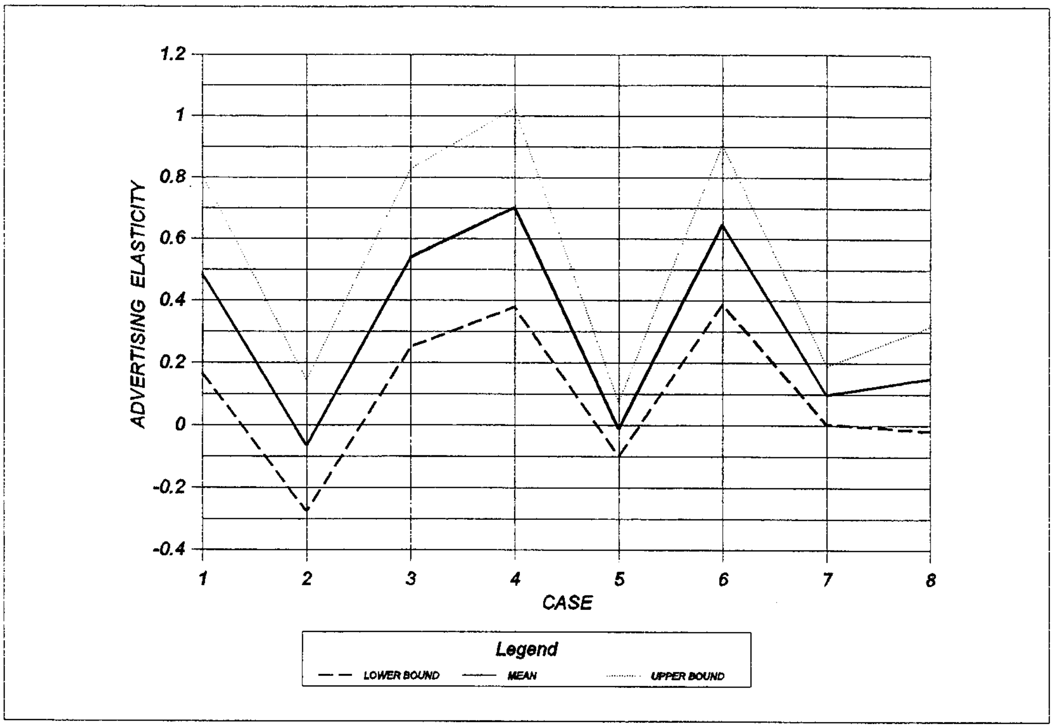


Figure 9. 95% Confidence Interval for Advertising Elasticity

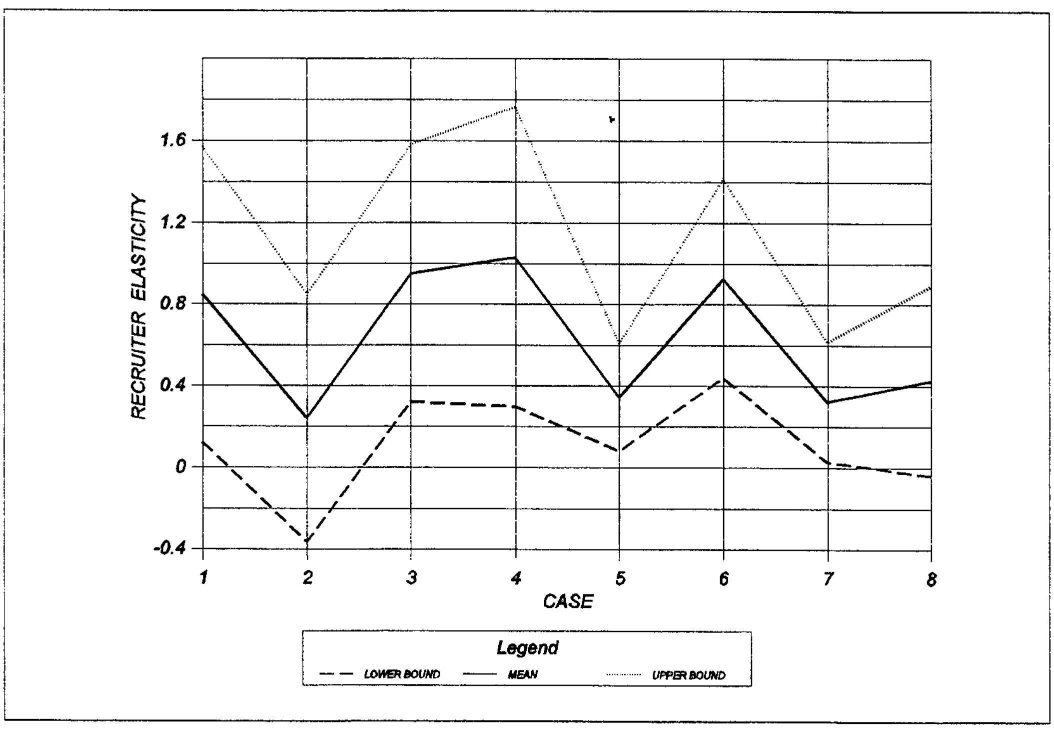


Figure 10. 95% Confidence Interval for Recruiter Elasticity

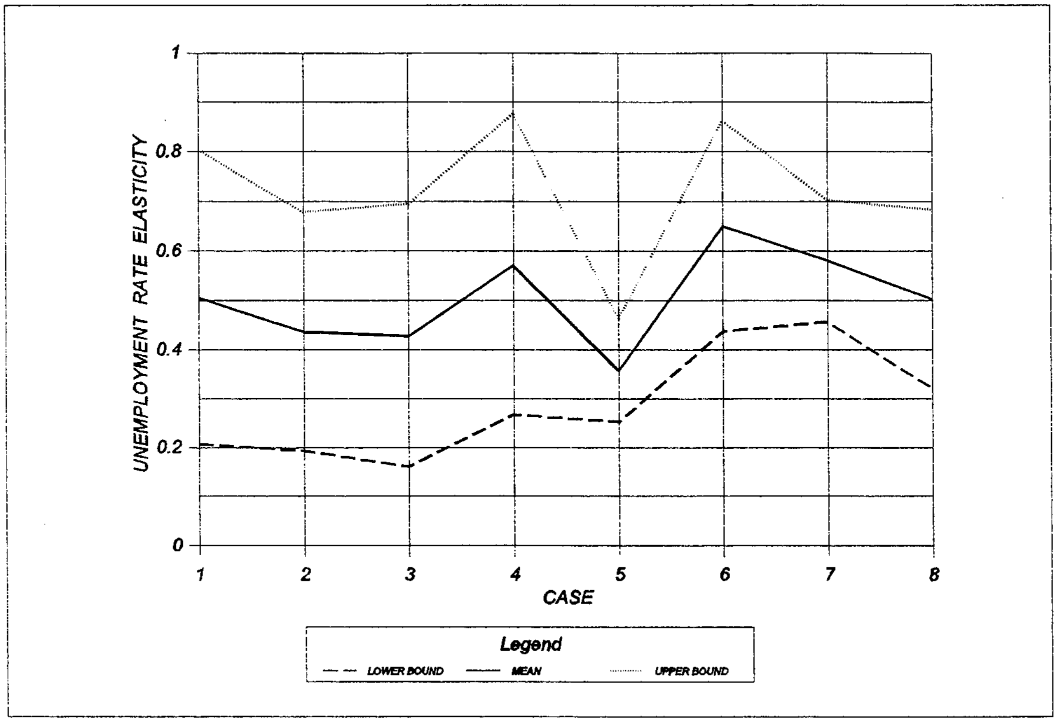


Figure 11. 95% Confidence Interval for Unemployment Rate Elasticity

These intervals can be interpreted as follows. As advertising expenditure increases by 1%, it is expected that high quality enlistments would increase by 0.15% on average and by a maximum of 0.32% with 95% confidence. In other words, at least 3.15% increase in advertising expenditure is needed to increase high quality enlistments by 1%. Likewise, as the number of recruiters increases by 1%, it is estimated that high quality enlistments would increase by 0.43% on average and by a maximum of 0.89% with 95% confidence. That is, minimum 1.12% expansion in the number of recruiters can be expected to increase high quality enlistments by 1%. In terms of cost, based on the historical data for the Army recruiting from FY81 to FY89 as given in Table 12, at least an additional 2.85 million dollars (FY95 constant) should be spent for the Army advertising to increase the high

quality enlistments by 1% (about 492 personnel). Using the same logic, minimum of 1.87 million dollars (FY95 constant) are needed in the recruiter expenditure to recruit the same amount of increase in high quality enlistments. Generally speaking, the military pay for the recruiters appears to be more cost-effective in producing high quality recruits than advertising expenditure, when the cumulative long-run effects for advertising were ignored.

For the other services (except the Army), the 95% confidence intervals obtained from the advertising and recruiters provide expected elasticities based on the random effects models that contain both competition and goal factors as (-0.09821, -0.01223, 0.07374) and (0.08310, 0.34657, 0.61005) as shown in case 5 of Figures 9-10. These confidence intervals can be explained as follows. When advertising expenditure increases by 1%, it is expected that high quality contracts would increase by a maximum of 0.07% with 95% confidence. In other words, a 13.56% increase in advertising expenditure expands high quality enlistments by at most 1%. Similarly, a 1.64% increase in the number of recruiters could be expected to increase high quality enlistments by at most 1%. However, note that the WLS model based on 95% confidence intervals for the mean recruiter elasticity (-0.0377, 0.8904) is relatively wide, which indicates that some additional factors are needed in the random effects model for recruiter elasticity to explain the remaining variation and to enhance the model fit.

**Table 12. HISTORICAL DATA FOR THE ARMY RECRUITING FROM FY81 TO FY89**

| | FY81 | FY82 | FY83 | FY84 | FY85 | FY86 | FY87 | FY88 | FY89 | TOTAL | AVG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ACF EXP[3] | 0 | 0 | 0 | 0 | 76.8 | 155.2 | 102.0 | 72.7 | 60.5 | 467.2 | 51.9 |
| EB EXP[3] | 106.9 | 149.1 | 163.6 | 140.7 | 129.1 | 136.3 | 83.4 | 47.5 | 49.4 | 1006.0 | 111.8 |
| AD EXP[3] | 87.0 | 93.0 | 92.0 | 87.9 | 103.4 | 102.6 | 92.0 | 80.5 | 76.4 | 814.8 | 90.5 |
| # OF RECRUITERS | 4977 | 4841 | 5003 | 4964 | 5318 | 5203 | 5357 | 5642 | 5905 | 47210 | 5245.6 |
| # OF HIGH QUALITY RECRUITS | 28863 | 39152 | 49696 | 52166 | 53755 | 57573 | 58439 | 52025 | 51100 | 442769 | 49196.6 |
| ESTIMATED PAY FOR RECRUITERS[4] | 158.4 | 154.1 | 159.3 | 158.0 | 169.3 | 165.6 | 170.5 | 179.6 | 188.0 | 1502.8 | 167.0 |

(Source : USAREC)

[3]FY95 constant million dollars.

[4]The number of recruiters × \$31,834 (composite cost for enlisted personnel by the DoD, FY95). This figure may underestimate the recruiters' true pay as much as 20%, because USAREC is composed mostly of senior enlisted personnel (the recruiters).

# VI. CONCLUSIONS

## A. SUMMARY OF RANDOM EFFECTS MODELS

In this thesis, the econometric analyses of high quality recruiting based on military recruiting data sets from FY81 to FY89 were reviewed. Three factors (Service, Competition, Goal) were employed in an effort to observe variation in high quality enlistments elasticities with respect to advertising, recruiter, and unemployment rate. A random effects linear model is fitted for each recruiting component based on the actual study results. Army advertising turns out to be more effective than that of the other military services. Elimination of the recruiting goal from the military recruiting analysis appears to bring significantly high quality elasticities with respect to advertising and recruiter effort. None of the factors turns out to be significantly dependent on the variation in unemployment rate elasticity.

For the Army, when goal and other services competition components are included in the analysis, random effects models provide the estimated high quality elasticity with respect to advertising expenditure, recruiter effort, and unemployment rate as 0.150, 0.426, and 0.502 respectively . In sum, it appears that the Army advertising elasticity on the high quality contract is relatively low compared to the unemployment rate and the recruiter elasticities. In terms of cost, at least an additional 2.85 million dollars (FY95 constant) should be spent for the Army advertising in order to increase the high quality enlistments

by 1% (about 492 personnel). Using the same method, an additional minimum of 1.87 million dollars (FY95 constant) are needed in the recruiter expenditure to recruit the same amount of increase in high quality enlistments.

## B. RECOMMENDATIONS

The three factors and the case studies used in this thesis may not be exhaustive. One of the additional factors to be further considered in the meta analysis for the military recruiting models is different estimation methods, provided that there are sufficient replicated studies in which the same estimation method is used.

In the analysis of random effects meta analysis models, it was assumed that the results of each published study are independent of each other. However, it is possible that some study results might be related due to the estimation of slightly different models on the same data set. Although neglecting the potential dependence in the random effects meta analysis models does not appear to have a significant impact on the inference procedure, a sensitivity analysis based on Monte Carlo simulation is recommended for further study.

In analyzing a set of three elasticities (advertising, recruiter, and unemployment rate), a multivariate analysis could be applied. However, in general, the covariance matrices for estimated elasticities for several recruiting components are not reported in the literature and subsequent analysis is infeasible. All studies reviewed in this thesis assume a constant elasticity, which does not necessarily reflect the dynamic feature of military recruiting.

It is recommended that authors report the covariance matrix of the estimated elasticities and a time varying coefficient method (Parsons 1975; Tegene 1992; Riddington 1993) be used to estimate elasticities for future research in the area of high quality military recruiting.

# APPENDIX A. GAMS PROGRAM

```
$TITLE THESIS GAMS PROGRAM
$STITLE MAX VALUE USING MAXLIKEHOOD FUN TO FIND GAMMA,VALUE,SIGS
*-----------GAMS AND DOLLAR CONTROL OPTIONS--------------------------
$OFFUPPER OFFSYMLIST OFFSYMXREF

OPTIONS
  LIMCOL =  0  , LIMROW  =  0   , SOLPRINT = OFF , DECIMALS = 8
  RESLIM =  100, ITERLIM = 10000, OPTCR    = 0.0 , SEED     = 3141;
*------------------------------------------------------------------------------------
*TO FIND AD WITHOUT  WEIGHT
SETS
 I   /1*16/
 J   /INTC,ARMY,COMP,GOAL/;

TABLE  X(I,J)
        INTC ARMY COMP GOAL
   1      1     1     0     1
   2      1     1     0     0
   3      1     1     0     0
   4      1     1     1     1
   5      1     1     1     1
   6      1     0     1     1
   7      1     0     1     1
   8      1     0     1     1
   9      1     0     1     1
   10     1     0     1     1
   11     1     0     1     1
   12     1     1     0     1
   13     1     1     0     1
   14     1     1     0     1
   15     1     1     0     1
   16     1     1     0     1;

PARAMETER SEBETA(I)  STANDARD ERROR OF  AD I
  /1  0.107, 2  0.106, 3  0.108, 4  0.04, 5  0.041, 6  0.008, 7  0.007,
   8  0.015, 9  0.015, 10  0.005, 11  0.02, 12  0.0044, 13  0.0436,
   14  0.0076, 15  0.0058, 16  0.0119 /;
PARAMETER VARBETA(I)  VARIATION OF AD I;
VARBETA(I)=SQR(SEBETA(I));
```

```
PARAMETER
  BETA(I)    ESTIMATE BETA
  /1 0.43, 2  0.58, 3  0.72, 4  0.103, 5  0.198, 6  0.015, 7  -0.001, 8  -0.034, 9  -0.038,
   10 -0.017, 11 0.001, 12  0.0231, 13  0.34, 14  0.01, 15  0.05, 16  0.02/;
VARIABLES
  VALUE
  B0
  B1
  B2
  B3;
POSITIVE VARIABLE
  SIGS;

B0.L=0.487167;
B1.L=0.162833;
B2.L=0.004983;
B3.L=-0.504483;
SIGS.L=0.00075;
VALUE.L=0.00;

$ONTEXT
 LOGISTIC-NORMAL
$OFFTEXT

EQUATION
 NORMAL;

NORMAL..VALUE=E=-0.5*SUM(I,LOG((2*3.1459)*(SIGS+VARBETA(I))))
   -0.5*SUM(I,SQR(BETA(I)-(B0*X(I,'INTC')+B1*X(I,'ARMY')+B2*X(I,'COMP')
   +B3*X(I,'GOAL')))/(SIGS+VARBETA(I)));
MODEL STAT /ALL/;
SOLVE STAT USING NLP MAXIMIZING VALUE;
DISPLAY SIGS.L,VALUE.L,B0.L,B1.L,B2.L,B3.L;
```

# APPENDIX B. SAS PROGRAM

```
OPTIONS LS=75;

DATA ONE;
INPUT STUD  $ COMP  GOALID   ARMY   AD  REC  GOAL   UNEM   SEAD SEREC
            SEGOAL   SEUNEM  ;
CARDS;
 KHGGP  0  1   1  0.43     0.48     0.33    0.57     0.107   0.133   0.068   0.064
  KHGP  0  0   1  0.58     0.68      .      0.65     0.106   0.138    .      0.069
   KHG  0  0   1  0.72     1.15      .      0.65     0.108   0.095    .      0.071
   WAT  1  1   1  0.103    0.371    0.215   0.554    0.04    0.074   0.023   0.026
    WA  1  1   1  0.198    0.482    0.299   0.451    0.041   0.076   0.022   0.025
   WNT  1  1   0  0.015    0.412    0.257   0.477    0.008   0.047   0.059   0.024
    WN  1  1   0  -0.001   0.459    0.316   0.441    0.007   0.047   0.058   0.022
   WFT  1  1   0  -0.034   -0.045   0.280   0.203    0.015   0.05    0.055   0.028
    WF  1  1   0  -0.038   -0.168   0.318   0.139    0.015   0.048   0.055   0.027
   WMT  1  1   0  -0.017   0.487    0.032   0.483    0.005   0.076   0.047   0.03
    WM  1  1   0  0.001    0.957    -0.195  0.402    0.02    0.066   0.046   0.031
    DP  0  1   1  0.0231   0.542    0.134   0.512    0.0044  0.064   0.055   0.107
GOLD1D  0  1   1  0.34     0.16     0.49    0.43     0.0436  0.08    0.0328  0.04
GOLD2D  0  1   1  0.01     0.29     0.21    0.72     0.0076  0.216   0.041   0.075
GOLD1A  0  1   1  0.05     0.15     0.28    0.59     0.0058  0.031   0.01    0.018
GOLD2A  0  1   1  0.02     0.35     0.13    0.76     0.0119  0.33    0.053   0.126
 CASE1  0  0   0   .        .        .       .        .       .       .       .
 CASE2  0  1   0   .        .        .       .        .       .       .       .
 CASE3  1  0   0   .        .        .       .        .       .       .       .
 CASE4  1  0   1   .        .        .       .        .       .       .       .        ;

DATA ONE; SET ONE;

WAD=1/(SEAD**2+0.00540190); WREC=1/(SEREC**2+0.06807596);
WGOAL=(1/SEGOAL)**2;   WUNEM=1/(SEUNEM**2+0.01025800);
A='&' ; E= '\\' ;

PROC SORT; BY ARMY COMP GOALID ;
PROC PRINT;

PROC SUMMARY DATA=ONE ;
VAR AD REC UNEM GOAL; CLASS ARMY COMP GOALID  ;
OUTPUT  OUT=OUT MEAN=    ; PROC PRINT;
```

```
PROC REG DATA=ONE;
MODEL AD  = ARMY COMP GOALID;WEIGHT WAD;
OUTPUT  OUT=OUT2 P=PAD   U95M=UAD L95M=LAD;
PROC PRINT DATA=OUT2;VAR LAD PAD UAD;

PROC REG DATA=ONE;
MODEL UNEM= ARMY COMP GOALID;WEIGHT WUNEM;
OUTPUT OUT=OUT3 P=PUNEM U95M=UEM L95M=LEM;
PROC PRINT  DATA=OUT3;VAR LEM PUNEM UEM;

PROC REG DATA=ONE;
MODEL REC = ARMY COMP GOALID;WEIGHT WREC;
OUTPUT OUT=OUT4 P=PREC U95M=UR L95M=LR;
PROC PRINT DATA=OUT4; VAR LR PREC UR;

PROC REG DATA=ONE;
MODEL GOAL = ARMY COMP;WEIGHT WGOAL;
OUTPUT OUT=OUT5 P=PGOAL U95M=UG L95M=LG;
PROC PRINT DATA=OUT5;VAR LG PGOAL UG;

DATA ALL; SET OUT2; SET OUT3; SET OUT4;SET OUT5;
```

# LIST OF REFERENCES


1. Assmus, Gert, John U. Farley, and Donald R. Lehmann (1984), "How Advertising Affects Sales : Meta Analysis of Econometric Results ," *Journal of Marketing Research*, 21, (February) 65-74.
2. Berner, Kevin and Thomas Daula (1993), "Recruiting Goals, Regime Shifts, and the Supply of Labor to the Army," *Defence Economics*, 4, (October) 315-38.
3. Bryk, A.S. and Raudenbush, S.W.(1992), *Advanced Quantitative Techniques in the Social Sciences Series 1* pp. 155-161, Newbury Park, CA.
4 Chandrashenkaran, Murali and Beth Walker (1993), "Meta Analysis with Heteroscedastic Effects," *Journal of Marketing Research*, 30, (May) 246-55.
5. Charnes, Abraham, Boaz Golany, Utai Pitaktong, John Rousseau and Li (1992), *Final Report : Enhanced FARRS-SHARE System* (September), Center for Cybernetic Studies, University of Texas at Austin, TX.
6. Daula, Thomas and Alton Smith (1985), "Estimating Enlistment Models for the U.S. Army," *Research in Labor Economics* Vol. 7, Ronald G. Ehrenberg, ed. Greenwich, CT : JAI Press Inc., 261-309.
7. Dertouzos, James (1989), "The Effects of Military Advertising : Evidence from the Advertising Mix Test," RAND note, N-2907-FMP, (March) Santa Monica, CA, RAND.
8. Dertouzos, James and Michael Polich (1989) "Recruiting Effects of Army Advertising," RAND Report R-3577-FMP, (January) Santa Monica, CA, RAND.
9. Diem, John and John Liukkonen (1988), "A Comparative Study of Three Methods for Analyzing Longitudinal Pulmonary Function," *Statistics in Medicine* 7, (July)19-28.
10. Goldberg, Lawrence (1982), "Recruiters, Advertising, and Navy Enlistments, "*Naval Research Logistics Quarterly*, 29, (June) 385-98.
11. Goldberg, Lawrence (1990),"The Effect of ACF Benefits on Army Enlistments," Final Report, prepared for the U.S. Army Recruiting Command, Reston, VA, Economic Research Laboratory, Inc.

12. Goldberg, Lawrence (1991), "Recent Estimates of Enlistment Supply Models," Final Report, prepared for the Office of the Assistant Secretary of Defense, Reston, VA, Economic Research Laboratory, Inc.

13. Hanssens, Dominique, and Henry Levien (1983), "An Econometric Study of Recruiting Marketing in the U.S. Navy," *Management Science* 29, (October) 1167-84.

14. Hunter, J. E. and Schmidt, F. L.(1990), *Methods of Meta Analysis*, Newbury Park, CA.

15. Kearl, Cyril, David Horne and Curtis Gilroy (1990), "Army Recruiting in a Changing Environment," *Contemporary Policy Issues*, 8, (December) 68-78.

16. Kostiuk, Peter and Dean Follmann (1989), "Learning Curves, Personal Characteristics, and Job Performance," *Journal of Labor Economics*, 7, (April) 129-46.

17. Lovell, Knox and Richard Morey (1991), "The Allocation of Consumer Incentives to Meet Simultaneous Sales Quotas : An Application To U.S. Army Recruiting, " *Management Science*, 37, (March) 350-67.

18. Lovell, Knox, Richard Morey and Lisa Wood (1991), "Cost-Efficient Military Recruiting : An Econometric Approach," *Defence Economics*, 2, (October) 339-51.

19. Morey, Richard (1991), "The Impact of Changes in the Delayed-Entry Program Policy on Navy Recruiting Cost," *Interfaces*, 21, (July-August) 79-91.

20. Office of the Assistant Secretary of Defense(1990), "Population Representation in the Military Services, FY1989," Department of Defense, Washington, D.C., July.

21. Office of the Assistant Secretary of Defense(1992), "Joint-Service Effects to Link Military Enlistment Standards to Job Performance(Report to the House Committee on Appropriations)," Department of Defense, Washington, D.C., April.

22. Parsons, Leonard (1975), "The Product Life Cycles and Time Varying Advertising Elasticities," *Journal of Marketing Research*, 12, (November) 476-580.

23. Polich, Michael, James Dertouzos and James Press (1986), *The Enlistment Bonus Experiment*, RAND Report, R-3353-FMP, Santa Monica, CA, RAND.

24. Pindyck, Robert and Donald Rubinfeld (1991), *Econometric Models and Economic Forecasts*, New York, McGraw-Hill.

25. Riddington, G1 (1993), "Time Varying Coefficient Models and Their Forecasting Performance,"

*OMEGA International Journal of Management Science*, 21, (October) 573-83.

26. Rust, Ronald, Donald Lehmann, and John Farley (1990), "Estimating Publication Bias in Meta Analysis," *Journal of Marketing Research*, 27, (May) 220-6.
27. Searle, Shayle, Geroge Casella and Charles McCulloch (1992), *Variance Components*, New York, John Wiley & Sons, Inc.
28. Sohn, So Young and Maniak Mazumdar(1989), "A Monte Carlo Study of Variable Selection and Inferences in a Two Stage Random Coefficient Linear Regression Model with Unbalanced Data," *Communications in Statistics*, 20, (December) 3761-91.
29. Steele, Dennis(1995), "Active Army Reduced to 10 Divisions," *ARMY Vol.45*, Arlington,Va, February.
30. Szymanski, David and Paul Bunch (1987), "Identifying the Genetics-Prone Consumer : A Meta Analysis," *Journal of Marketing Research*, 24, (November) 425-31.
31. Toughen, Abebayehu (1992), "Kalman Filter and the Demand for Cigarettes," *Applied Economics*, 23, (July) 1175-82.
32. U.S. Department of the Army(1989), *Army Focus p. 18*, Washington, D.C. : Pentagon, November.
33. Warner, John (1990), "Military Recruiting Programs During the 1980s : Their Success and Policy Issued," *Contemporary Policy Issues*, 8, (October) 47-67.

# INITIAL DISTRIBUTION LIST

| | | No. Copies |
|---|---|---|
| 1. | Defense Technical Information Center<br>Cameron Station<br>Alexandria, VA22304-6145 | 2 |
| 2. | Library, Code 052<br>Naval Postgraduate School<br>Monterey, CA 93943-5101 | 2 |
| 3. | Professor So Young Sohn, Code OR/Sh<br>Naval Postgraduate School<br>Monterey, CA 93943-5000 | 1 |
| 4. | Professor Harold J. Larson, Code OR/La<br>Naval Postgraduate School<br>Monterey, CA 93943-5000 | 1 |
| 5. | Library<br>Republic of Korea Army Headquarters<br>Nonsan-kun, Dooma-myun, Boonam-Ri<br>Choong Nam, Korea, 320-919 | 1 |
| 6. | Lt.Col. Park, Bong Suk<br>Dept. of Personnel Education<br>Nonsan-kun, Dooma-myun, Boonam-Ri, P.O. Box 4<br>Choong Nam, Korea, 320-919 | 1 |
| 7. | Chung, Yeon Chang<br>Dongdaemun-Gu, Hwikyung 2-Dong 276-32<br>Seoul, Korea | 2 |
| 8. | Woodang Library<br>Nowon-Gu, Gongneung-Dong, P.O. Box 77<br>Korea Military Academy<br>Seoul, Korea, 139-799 | 1 |